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Popular Science

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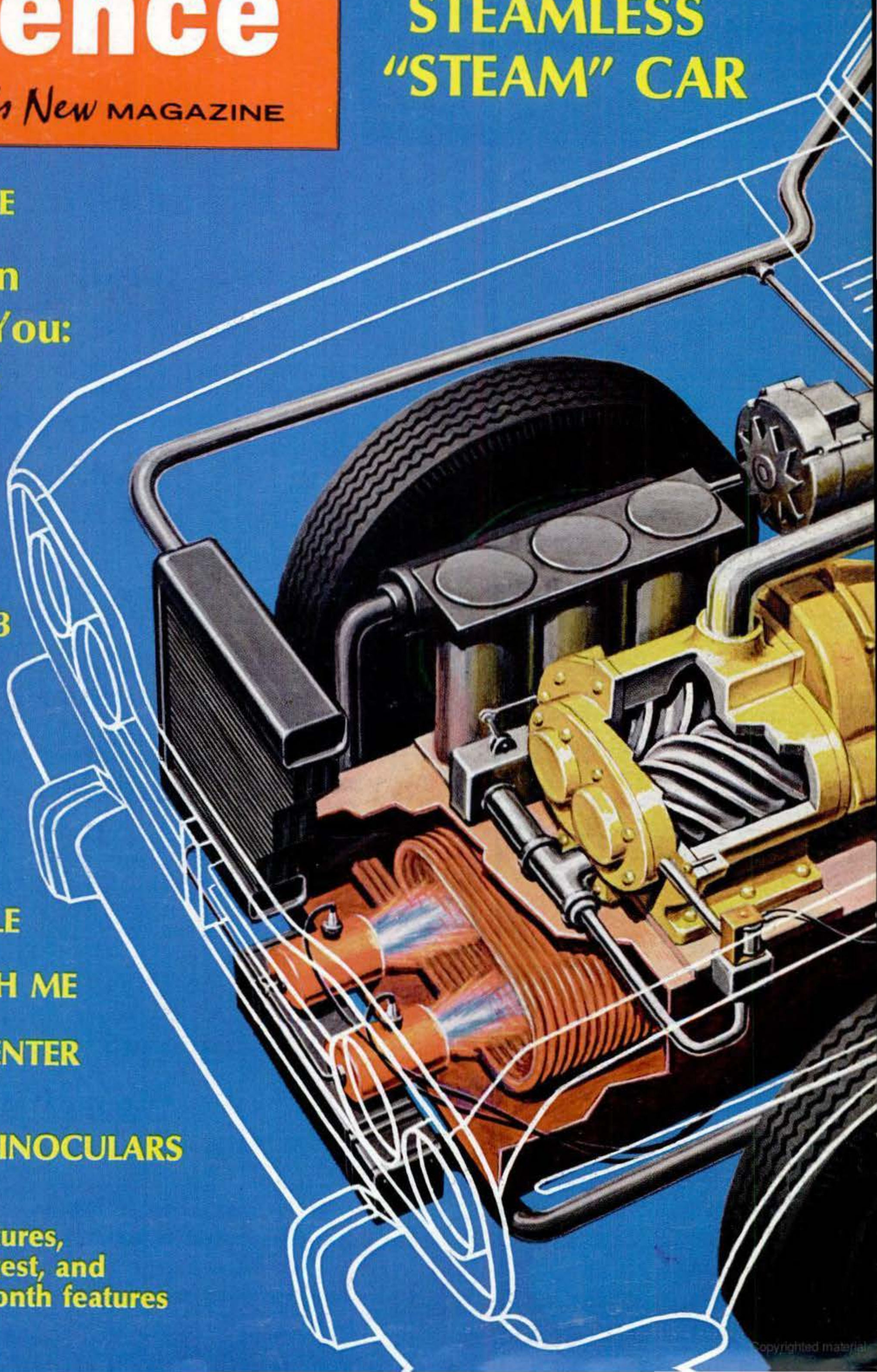

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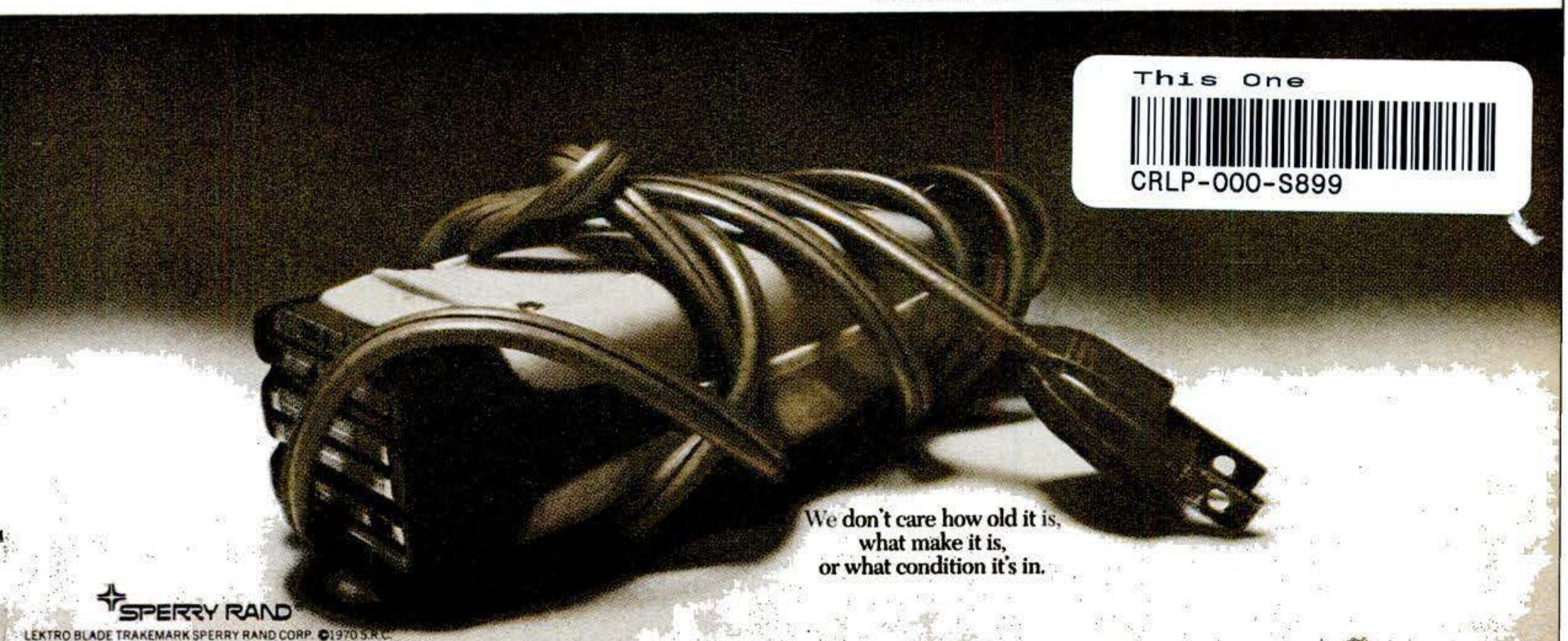

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OCTOBER 1970 Founded in 1872/Vol. 197, No. 4

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This inventor's car moves out with just a whisper—and leaves no trail of pollutants. Power comes from expanding refrigerant in a closed circuit.

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Why Apollo 13 Failed By C. P. GILMORE PAGE 64
At last—the real story. Gilmore went behind the scenes at NASA to unravel the incredible sequence of events that made the world hold its breath.

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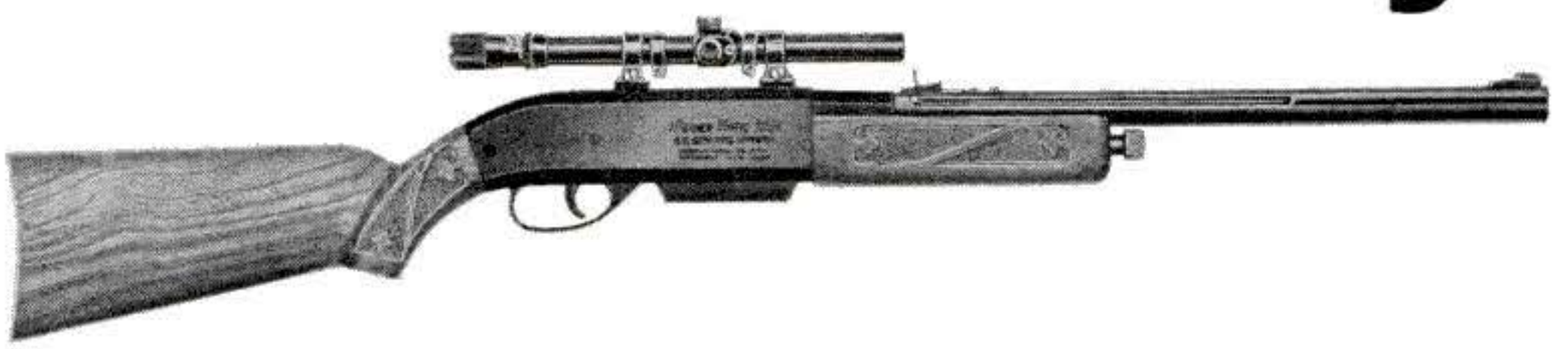
The fast new member of a famous family.



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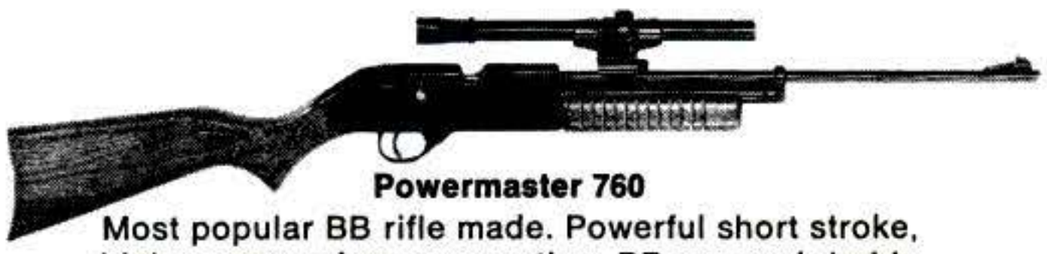

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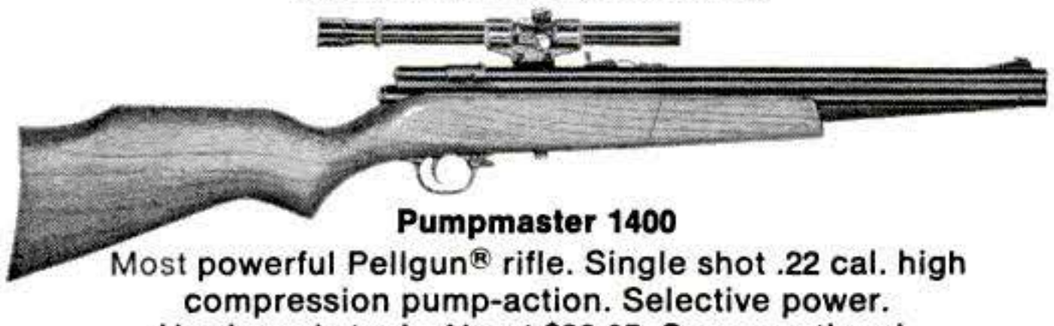

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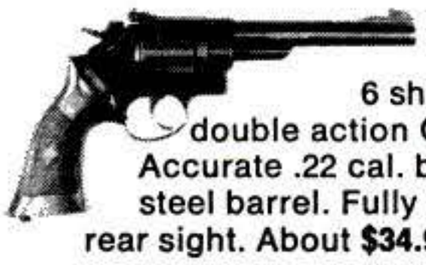

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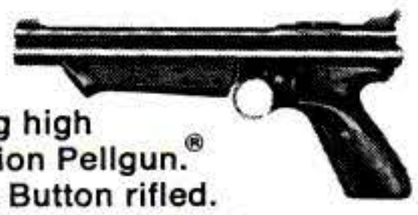

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What's New NEXT MONTH

EVER want to crawl away from it all to think things out? Everybody needs a meditation corner—preferably one that surrounds you with mental stimulation. Kenneth Isaacs, PS Design Consultant and pioneer in educational environments, went back to the Greek dodecahedron for the basic shape. Each of the 12 faces is papered, inside, with photos cut from magazines; wrapped up in this collage of your choice, you explore fresh relationships and begin to "put things together." Wingnut assembly lets you store the pentagons flat. Full plans and instructions next month.

Meanwhile, Isaacs is accepting dates for a lecture tour of U.S. colleges, and the PS Meditator will go with him as part of his demonstration. His new book "Culture-Breakers, Alternatives, and Other Numbers" currently is being used as a text in the art/architecture schools of four universities.

AND—there's lots more coming in November PS: new ideas and new developments rolled out for you. Like—

- **The Car Detroit Doesn't Make: 4 Doors, 4 Seats, 4 Cylinders**
- **Home Entertainment for '71: New Sight and Sound Systems . . . Revolutionary Stereo Headphones . . . Natural Color in the New TVs . . . Hi-Fi Cassettes That Rival Discs**
- **The New Warranties: Will the Customer Be Right at Last?**
- **Wernher von Braun: How New Weather Satellites Will Give You More Reliable Forecasts**
- **4-Wheel Antilock Brakes Make Sure Stops**
- **How Science Will Foil Skyjackers**

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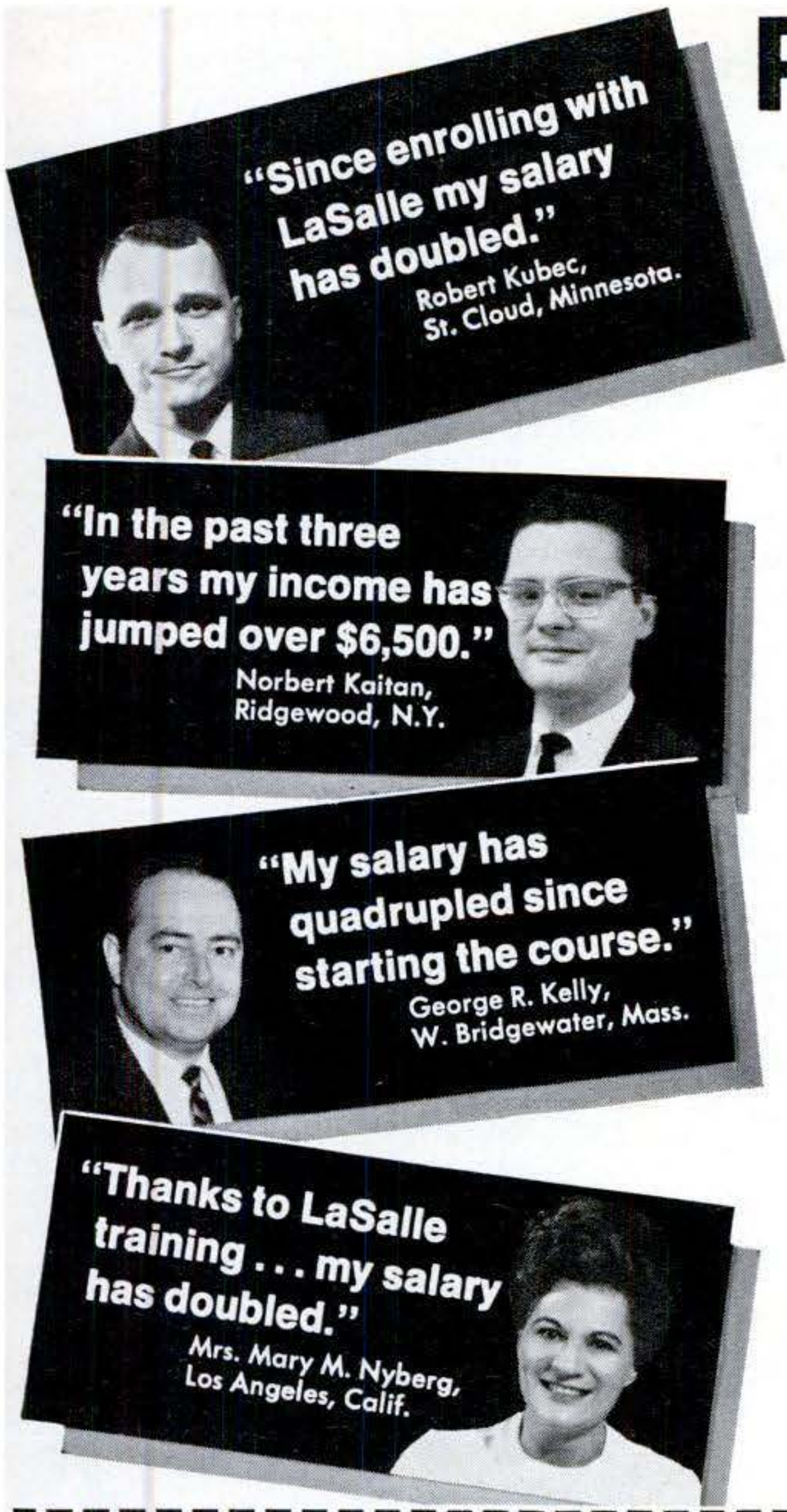
WHO ELSE WANTS A BIG RAISE IN PAY?



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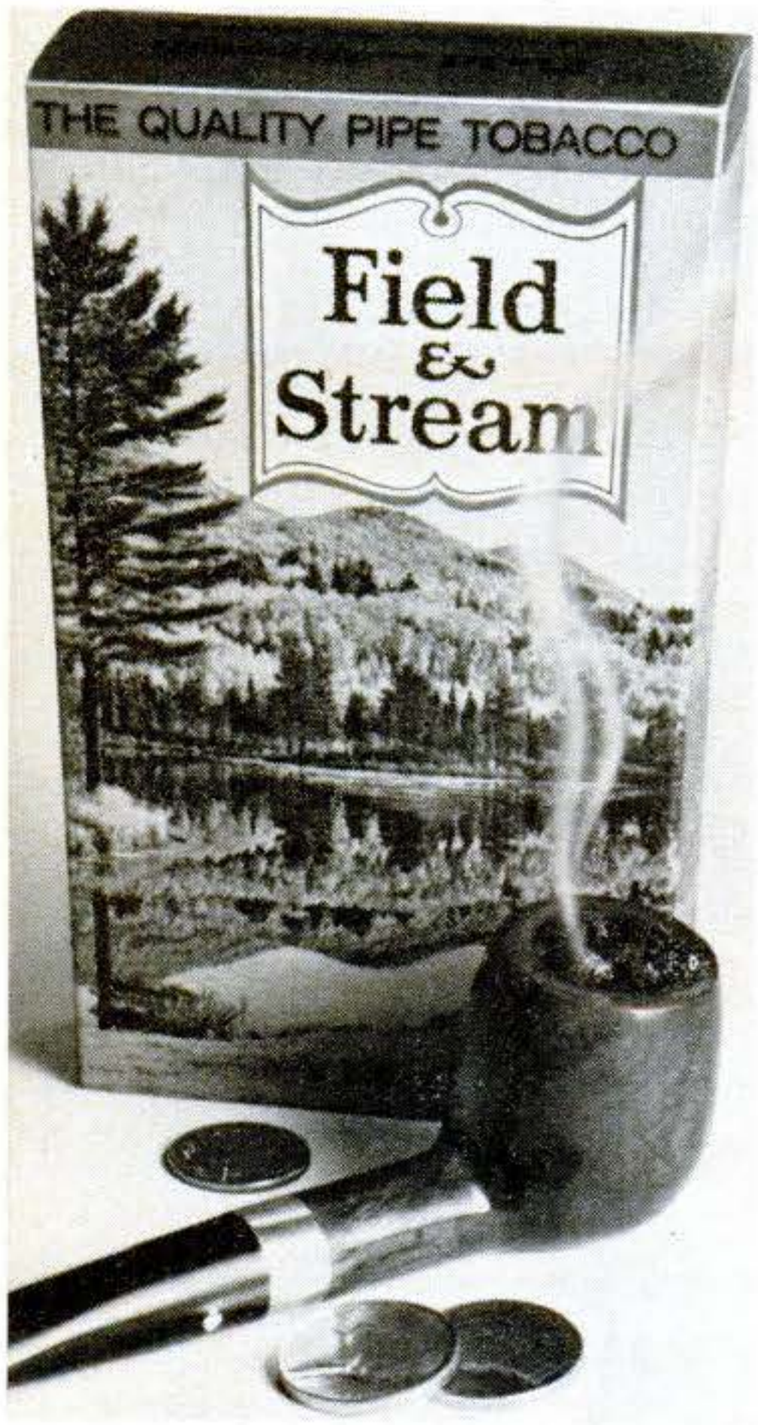
When your daughter says that Field & Stream's aroma reminds her of a great autumn day in the woods...

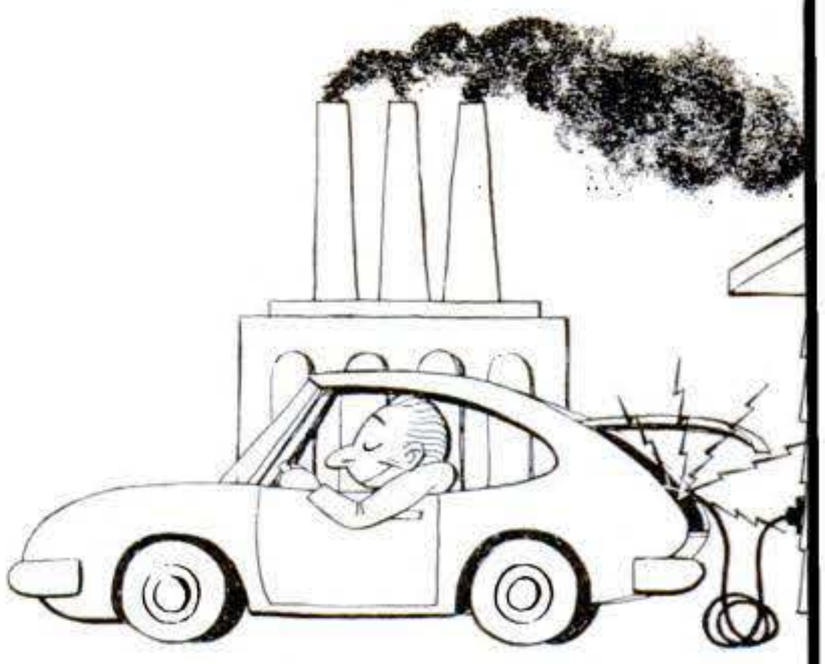


start saving up the dowry.

A quality product of Philip Morris U.S.A.

PS Readers Talk Back

Where you voice your views . . . and the editors do the listening



Questions Detroit's priorities

I enjoyed your excellent automotive coverage in "First Color Photographs of the '71 Cars" [Aug.]. But isn't it unjust that the auto industry spends so much on the yearly style change, but spends so little on safety or pollution-control research?

MICHAEL FLYTE,
Medford, Ore.

Danger in sandbag ballast

In your report on the "Jeep Gladiator" [Aug.], you say "If you plan to use the truck as a pickup between camping trips, load a few sandbags in the bed." I have tried this in a car and found it extremely dangerous. When rounding a fairly sharp curve, the sandbags rolled over to the side of the trunk, changing the center of gravity. I almost lost control of the car.

R. J. RAWL, Graniteville, S. C.

While Charley Meyer suggested using sandbag ballast in the Gladiator, we agree it's a questionable idea for a standard car, with softer springs and suspension. And even in the Gladiator, bags should be wedged in place so they won't shift on turns.

Builds a barn beauty

Here's my Pennsylvania Dutch Barn built in April-May of this year from your plans. Construction was relatively simple and enjoyable. A few people were disappointed when I painted it to match my home and not traditional barn

red. Total cost was about $300, or about 35 cents per cu. ft. of storage space, compared to 65 cents per cu. ft. in average commercial metal storage sheds.

G. L. ANSPACH, Virginia Beach, Va.

Interested readers can purchase plans for the Red Barn by sending $3.95 to Popular Science Plans Division, 355 Lexington Ave., New York, N. Y. 10017.

Drawbacks of clean-air cars

In principle, "The Great Clean-A Car Race" [Aug.] is a good idea. But we go to electric cars, aren't we shifti the pollution from the car to the pow plant? Fossil-fuel plants pollute t air and cause thermal pollution. N clear plants cause thermal pollution a the conservationists are fighting the hydroelectric plants. Besides all this, the generating plants can't keep up with present demands—let alone 80 million cars.

W. M. BASCH,
Englewood, Fla.

Metric-system lesson

As a dispensing optician, I read wi much interest Dr. Jack Runninge article "Making Glasses Fit Your Jo [Aug.]. But there is one error which would like to correct about "photochr mic lenses." The article says the cry tals of these lenses are each "100,0 mm in diameter." If this prevails, heave help us when the U.S. converts to t metric system. The sentence should read: "Each crystal measures about one-hundred-thousandth of a millimeter in diameter."

F. M. RESTIVO JR., V.P.,
Louisiana Assn. of
Dispensing Opticians,
New Orleans

Right you are. Dr. Runninger use the right figure, but the inaccuracy crep in during editing.

Getting concrete comps straight

Richard Day's article "Now: A Con crete that Doesn't Need Joints" [July errs in coining the term "shrink-comp. All manufacturers listed at the end c the article do manufacture ChemCom cement, but we are not familiar with an product called "shrink comp." Chem Comp is the copyrighted name applie to the Klein cements (Alexander Klei developed ChemComp). The patents o this material are owned by the Chemi cally Prestressed Concrete Corp. of Va Nuys, Calif. Five manufacturers pro duce ChemComp under a license grant ed by this corporation.

R. E. TAGGART, Southwestern Port land Cement Co., Los Angele

Author Day says he cannot reall take credit for the term 'shrink-comp which is short for shrinkage-compensat ing concrete. He first heard it (at

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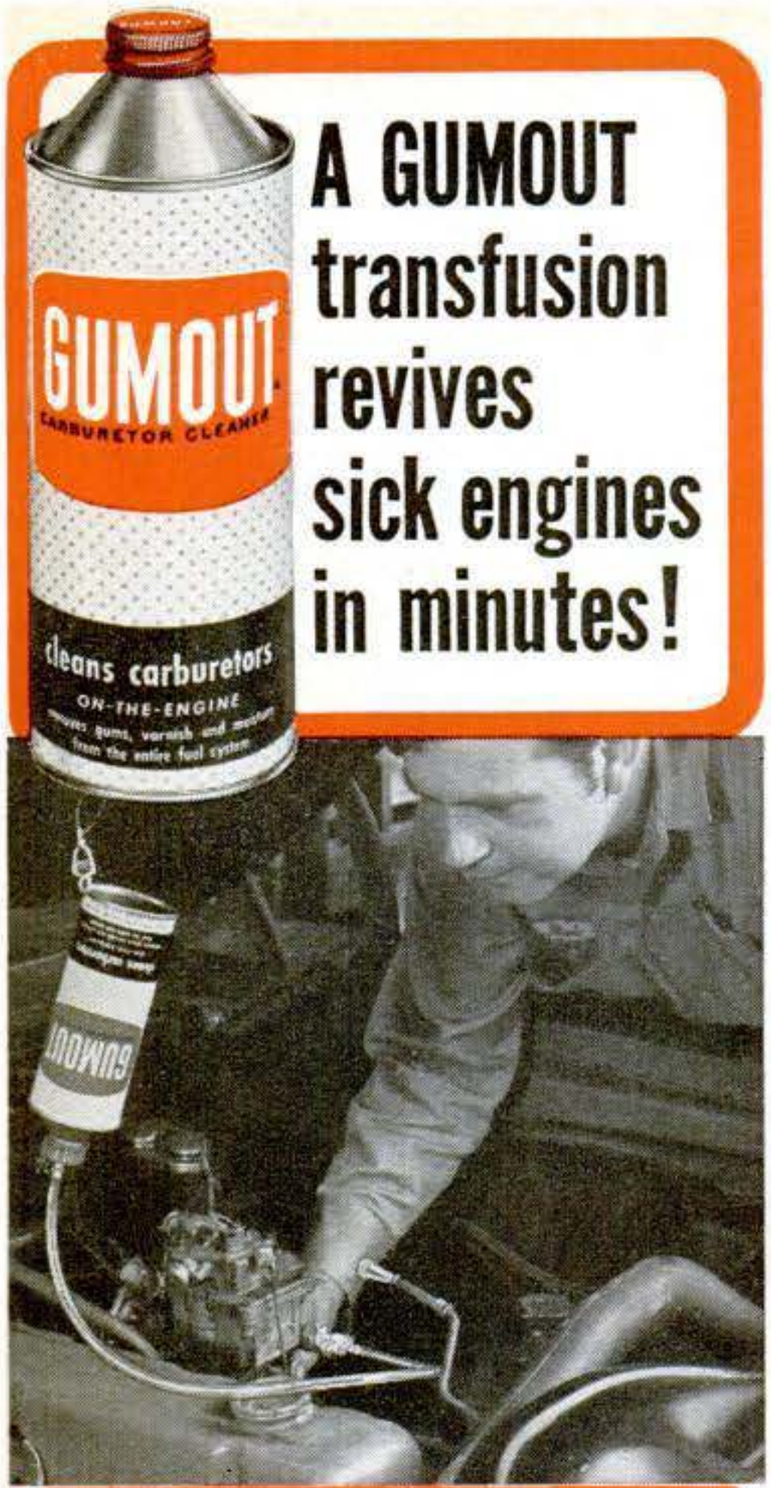

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Portland Cement Assn. course) long before there was a ChemComp. It should be applied, however, only to concrete made with an expansive cement such as ChemComp.

Idea's not so hot

In "New Ideas from the Inventors" [Aug.], you showed a system in which the water of a swimming pool would cool the condenser of an air conditioner. This would eliminate the need for a cooling tower, pool heater, and separate pumps.

We have used such a system for seven years, and because of one big deficiency I would not recommend it. When the temperature is cool the air conditioner does not run and so the pool is not heated when it most needs heating. When it's hot outdoors, the air conditioner runs almost constantly, heating the pool when you want that least. During a hot-weather period of more than two days the pool water gets so uncomfortably warm that it is no longer possible to enjoy a swim.

BRUCE KLEIN,
Hazel Green, Wis.

Clearwater's message comes home

"The Clearwater's Cargo is a Message: Stop Pollution" [Aug.] is typical of the majority of ecological articles—all talk and no practical solutions to the problems they create. After four pages of complaining about the polluted waterways of New York, they dumped their barrel of wastes in Long Island Sound.

As an avid hunter and fisherman, I have buried my own waste where it would do the most good, not harm.

Might I suggest the addition of a shovel to the tool locker of the good ship Clearwater, and the initiative to use it?

JOHN O. DAVIS, Livermore, Calif.

Super flywheel

PS covered a fine story in "Super Flywheel to Power Zero-Emission Car" [Aug.]. It is my sincere hope that this car will be developed in the near future. This machine is what society wants but may not produce—and that's a terrible irony.

G. R. BINER JR., Lincoln, Neb.

. . . My seven-year-old son Bill asked why the motor-generator was not enclosed in a vacuum can. He reasoned that parts of *that* motor would have to turn very fast to rev up the super flywheel.

EDWARD MESSNER, M.D.,
Boston, Mass.

. . . Electric heat and the super flywheel are clean and emission-free only at the point of use. A heat engine or nuclear power plant used to generate electricity does not convert all of t fuel energy into electricity. In fact or 30-40 percent is so used. The rest vented to the environment as therm pollution. The owner of the super f wheel vehicle or electrically heat home can pride himself that he perso ally is not polluting the environme but the power company is his surroga

The super flywheel would still be wonderful source of power in explosi atmospheres, under water, and in oth situations where personnel shock haza is high.

STEPHEN EISENSTE
W. Lafayette, In

Strives for perfect cut

R. J. De Cristoforo's article "Woo working Tools That Make You An E pert" [Aug.] has a built-in trap in h blade-projection gauge. The tool is me suring from the level of the dado inse which is visibly lower in the photogra than the permanent table. The wo usually rides level with the table and t depth of the cut will be just a smidg less than intended—enough to give a le than perfect result.

Having made this mistake too ma times, I use a combination square wi the flat extending over the dado inse onto the table, and the blade of the square against the saw blade to measure the projection. Even more accuracy can be had by using a second square on the blade of the first.

T. G. BIGGS JR., M.D.,
Oak Grove, La.

Pollution-cutting tips work

My thanks to E. F. Lindsley for h article on "Tuning Your Car to Cut Po lution" [Aug.]. I tried his method o my '67 Chevy and it came out succes fully. The only problem I encountere was setting the idle for low emissio

Thanks for your excellent step-by-ste instructions.

PAUL V. SILVA, Beverly, Mas

Sauna safety

In "What's New in Home Improve ment" [Aug.], you show a picture of tw pretty girls in a sauna which I foun very appealing to the eyes, but the hea er in the picture is misleading.

Some of your readers may think is a charcoal heater, and may get th bright idea to build their own sauna an install their barbecue grill as a heate I'm sure you know many people we killed last year by burning charcoal fo heat in a small room. I think you shoul explain that the heater is not a charco burner.

ANTHONY MONTAGN
Pleasantville, N.Y

Right you are, it's an electric heater and what looks like charcoal on top really rocks.

Want to get something off your chest? Write "Readers Talk Back," Popular Science, 355 Lexington Ave., New York, N.Y. 10017.

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It can shave you as close or closer than a platinum or chromium blade.

Every few years, somebody comes out with some new kind of razor blade.

Awhile ago, it was stainless steel.

Then it was chromium.

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But no matter what the blade makers do, their blades are still flat. And your face *isn't*.

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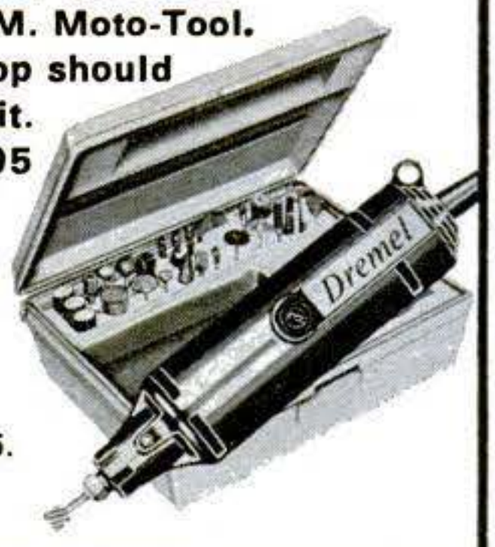

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Detroit Report...

WHATEVER HAPPENED TO THE HORSEPOWER RACE? The '71 Oldsmobile 455-cu.-in. V8 is rated at only 185 hp. Last year it was rated at 310 hp. Are engines becoming less efficient? No, Olds has gone to a new and more honest rating system. New horsepower ratings are "as installed." Up to now, power tests have been made with stripped engines under optimum conditions. Now they're equipped with air cleaner, exhaust system, heated air, normal ignition timing, and cooling fan.

Chevrolet slashed the cost of building its new Vega by drastically changing standard assembly methods. Fewer parts per car and automatic assembly are the two key features. Vega has 578 parts per car to be put together on the final assembly line. An Impala has 996. Broken down into individual pieces, Vega has 1,231 vs. 3,500 on Impala. Fewer parts mean less work on the assembly line. Advances made in automatic weld operations on the Vega body line are even more impressive. Vega has 95 percent of its 3,900 body welds done by machines. For the whole car, Vega's welds are 80 percent automatic vs. 20 percent on the average U.S. car.

More automatic assembly operations mean faster assembly lines, and Vega's assembly line is *superfast*. By December 1970, Chevy will turn out Vegas at a rate of 100 per hour, far faster than any other assembly line in the world. For comparison, Nova (next fastest GM line) is built at a rate of 65 per hour, about the speed of Volkswagen's final assembly. Many automatic operations pioneered by Vega will be copied by others. One is the automatic door-hanging machine. This robot carries doors to the car, locates and lines up the hinges, matches door to car, then installs the hinge pin—all without human guidance. Door hinges are automatically welded to doors and posts, and this operation is done with such high accuracy that alignment adjustments are said to be unnecessary.

General Motors does goof up once in a while. And most of us get a kick out of seeing the leader make a mistake. Vega's new aluminum engine is a case in point. When Chevy engineers received the first engine protoypes from General Motors' super-smart Engineering Staff, they found, upon installing the engines, that they were designed completely backwards! All hang-on equipment was on the wrong side, leaving no room for air-conditioning systems or heater ducting. First thing Chevy did was make a mirror-image version of the complete engine. They moved the intake and exhaust manifolds, carburetor, oil filter and other parts over to the opposite side. But one catastrophe Chevy planned for never happened: An iron-block engine was developed as a back-up for the aluminum. Just in case . . .

Government pressure, not competitive costs, may force GM to consolidate its engine lineup. Up to now, each GM division has designed and built its own engines. Since Chevrolet, Pontiac, Olds and Buick use V8 engines of near-identical size (350, 400, 455 cu. in.), there is much duplication of effort. But GM has stuck with the setup, since it promotes competition within the company, keeps each division's cars different from the others. Now all that might change. Massive effort needed to keep up with emission-control standards is just too time-consuming to be duplicated by each division. The result will be that one engine of a size will be used by all GM cars, and that engine will be assigned to one division for design and assembly.

GM's new clamshell tailgate has prompted Ford to develop a similar device. But the Ford version may never be seen on a production car. Even before GM unveiled the clamshell gate on its Chevy, Pontiac, Olds, and Buick wagons, Ford engineers were busy proving their own design. However, a number of drawbacks on the clamshell idea may keep it from spreading to other companies. It is slower opening than the current two-way tailgates used on Ford and Chrysler products; and it takes two separate movements to open the system—one for the glass, one for the gate. Also, the gate top forms a trap at the sides where a hand could get caught between gate and glass frame.

Look for government safety agencies to mount massive attack on pickup campers next. And with good reason. Camper bodies are heavy, have high center of gravity, and are affected dangerously by highway crosswinds. Trouble is that weights of camper bodies are not uniform. Some weigh as much as 50 percent more than manufacturer claims. When this extra weight is loaded on a pickup, you end up with a vehicle that is underpowered and unstable in certain driving maneuvers. Also, interiors of camper bodies are horror chambers of dangerous designs, with no thought given to protecting passengers in an accident.

Jim Dunne

Detroit Editor

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The Atlas Plycron 2 *plus* 2* fiberglass belted tire was subjected to one of the industry's toughest road testing programs. Results: The Atlas Plycron 2 *plus* 2 delivered an average of 35%† more miles than even the famous Atlas Plycron—traditionally, the tire that has outperformed 4 ply major brand replacement tires in mileage tests.

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"Say, Smokey—"

A clinic on cars by America's most famous mechanic

Each month in POPULAR SCIENCE Smokey Yunick answers questions on cars—family cars, high performance jobs, hot rods, and racing cars—selected from those sent in by readers. Got a problem? Send it to: "Say, Smokey—" Popular Science, 355 Lexington Ave., New York, N.Y. 10017. Questions cannot be answered by mail.

I am the original owner of a '67 Ford with 289-cu.-in. engine. The dealer has tuned the engine, installed a carburetor kit, plugs, points, PCV valve, etc. How come I can't get over 10 miles per gallon?

J. KENNETH STANFIELD, Wyanet, Ill.

The biggest reason I can imagine for your poor mileage is that you have a pretty heavy car for so small an engine, especially if you push it. Other reasons could be: Too high or too low a rear axle ratio, a camshaft not on the money, and—very commonly the culprits—late timing, or opening of the power system in the carb at too low a vacuum. Also look for too much fuel pressure, a high carburetor-float setting, a restricted carb air cleaner and/or an exhaust-system restriction.

I have a '69 Plymouth station wagon with 383-cu.-in. engine and two-barrel carburetor. It has run now for 15,000 miles and problems that have been with it from the start are worse. It starts good when cold but, when you step on the gas, the engine goes dead. Sometimes it coughs and backfires through the carburetor. It's risky taking off on the freeway before the engine is thoroughly warmed up. Two factory reps and two Plymouth garages could find no answer. They tried three new carbs, replaced the fuel pump, coil, and camshaft, and tried two new distributors. They even pulled the head, found two cylinders very black, and ground the valves. The electrical system checked out okay. Now what?

LOREN W. CURRINGTON, Clinton, Ohio

The coughing, backfiring, and dying on acceleration sound to me like it's getting too much air and not enough fuel. Also it's possibly late in timing at that rpm. Get someone to enrich the accelerator system a lot, first. If that doesn't cure it, check the distributor advance at acceleration. If it is still in trouble, have the intake manifold and gaskets checked for leaks. Series-gap plugs are pretty good in slow driving and acceleration.

We have a '70 Mercury Cougar XR-7 with the 351 V8. It idles at between 700 and 800 rpm, and when you shift into forward or reverse, the car jerks and the tachometer drops down to about 500. Also, when I stop at a light, it starts creeping quickly when I take my foot off the brake. My friend and I say it idles too fast, my father disagrees. Who's right, and what can be done?

A WOLFE, Waban, Mass.

You are right—500 to 550 rpm would be enough idle; and then I don't think it would jerk. Get the carburetor set to idle smoothly at the lower speed; then try it. It's possible that you'll have a stalling problem at the lower idling speed, and only a correct tune-up will cover that. If it still jerks at the lower idle, check the transmission-valve body adjustment and pump pressures.

A few months ago I purchased a '67 Mustang Six with three-speed manual transmission and 34,000 miles on the odometer. Starting at about 45 mph, it jerked or ran roughly on deceleration. Downshifting had little or no effect. I had a new carb, spark plugs, ignition points, condenser, and PCV valve installed and it was right "on specs"—still it jerked. Since the mechanics said nothing more could be done, I shelved the problem until I had to go in about leaking valve seals. Then they changed the same parts again and the problem got worse. Now the unevenness is not only apparent on deceleration, but also at steady speeds up to about 65 mph. Only during acceleration does it disappear. Now the garage tells me that only installing Cruise-O-Matic will cure the problem. What do you say?

W. R. JORGENSON, San Rafael, Calif.

Your problem seems to be connected to high manifold vacuum on deceleration. With the throttle closed, the manifold vacuum is about 22 inches. The jerk is then caused by early firing, or misfiring. Misfiring comes from too rich or too lean a mixture, early firing results from excessive distributor advance. Go by a process of elimination to pinpoint the exact trouble. Once cornered, the fix will be easy.

I heard a hissing sound from under the hood of my 1963 Chevy II wagon with 120-hp engine and automatic transmission. A mixture of radiator coolant and oil was running out of the radiator overflow pipe. The engine had overheated, though the warning light hadn't come on. A mechanic friend said it was probably a defective head gasket, so I pulled the head, and although the gasket was all right, I replaced it. This had no effect. I had thoroughly flushed the system, but oil again appeared in the radiator water. I can't see how the oil could possibly get into the water at the head gasket, since it would have to overcome the cooling-system pressure. The engine has always run very well, and still operates with no loss of power or other trouble except as noted. It is definitely engine oil, since after it does this awhile, the oil level is lower in the crankcase.

RALPH SLEEZER, Johnstown, N.Y.

You didn't say anything about water in the oil, so I assume it is only oil in the water. Oil pressure is about 50 psi and water pressure is only about 15 psi maximum, so a cracked or porous block that's opening up with heat would put oil into the water. This doesn't explain why the engine gets hot. I'd suggest you take it to a shop that has a Sun Analyzer and blow it down when it is hot. I think you'll find the leak, blowing both oil and pressure into your cooling system.

I recently purchased a 1968 Oldsmobile with 400-cu.-in. engine and two-barrel carb. At first I only got six mpg, but after several trips to the dealer it is up to eight in town and 10 on the highway, and he says that is the best he can do. Is this normal?

ERVIN MULLET, Goshen, Ind.

Your mileage is not normal, for a normal driver. Of course, high speed and bad start-off habits could be costing as much as five mpg, but I believe your biggest trouble lies in the engine. Get the car on a chassis dynamometer where they can observe mixtures under load and speed, and they will end the trouble. My guess from here is that power enrichment comes in and possibly ignition is retarded in the medium-speed range.

I plan to buy a '71 Dodge Coronet station wagon. On vacation it will have to carry a load of five people, luggage, and a roof-top carrier. It will be ordered with a heavy-duty suspension, A/C, power steering, and the smallest or the next size V8 engine. Assuming any type tires are available as original equipment, which would you recommend? If radial-ply tires are your choice, should they be steel-belted, all-rayon, or what? If radials are your recommendation, would you say they would negate the necessity of snow tires? Or if the area is one where snow tires are helpful, should a new car be purchased with fiberglass bias-belted tires, with snow tires used in winter?

ALBERT E. PICKUS, Cleveland, Ohio

I think the wire radials would be best, but I doubt if you'd be as well off in snow as with regular snow tires. Firestone and B. F. Goodrich have new and interesting radials on the market now—but not of steel. Fiberglass types wander in and out of trouble and might not be too good for your purpose. I'll probably catch all kinds of hell, but it's the way I see the tire situation right now.

Continued

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AC ENGINEERS THEM FOR YOUR KIND OF DRIVING

Automobile manufacturers install spark plugs to suit normal driving conditions . . . spark plugs that will perform well with an average "mix" of city and highway driving.

But some kinds of driving you may do require a cooler or hotter spark plug for best continuous performance.

For example, one or two ranges "cooler" than normal might give you better performance on the highway. A spark plug that is too hot could lead to pre-ignition and high speed missing.

On the other hand, stop-and-go driving in the city with extended idling periods, may call for a "hotter" heat range. Under these conditions a spark plug that runs too cool will not "burn off" fouling deposits.

How do you know what's "hotter" or "colder" for your engine? Check what the factory recommends as mid-range, and go from there . . . one step up or down in heat range at a time.

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AC uses a simple numbering system on the insulator that tells you the type, size, and heat range. The first number designates diameter. The second number indicates relative heat range . . . like a thermometer. The higher the number, the "hotter" the heat range. The lower the number, the "cooler" the heat range.

Prefix and suffix letters give Type and Design information. In this case, the prefix "R" means the spark plug is a resistor type and the suffix "S" indicates an extended tip design.

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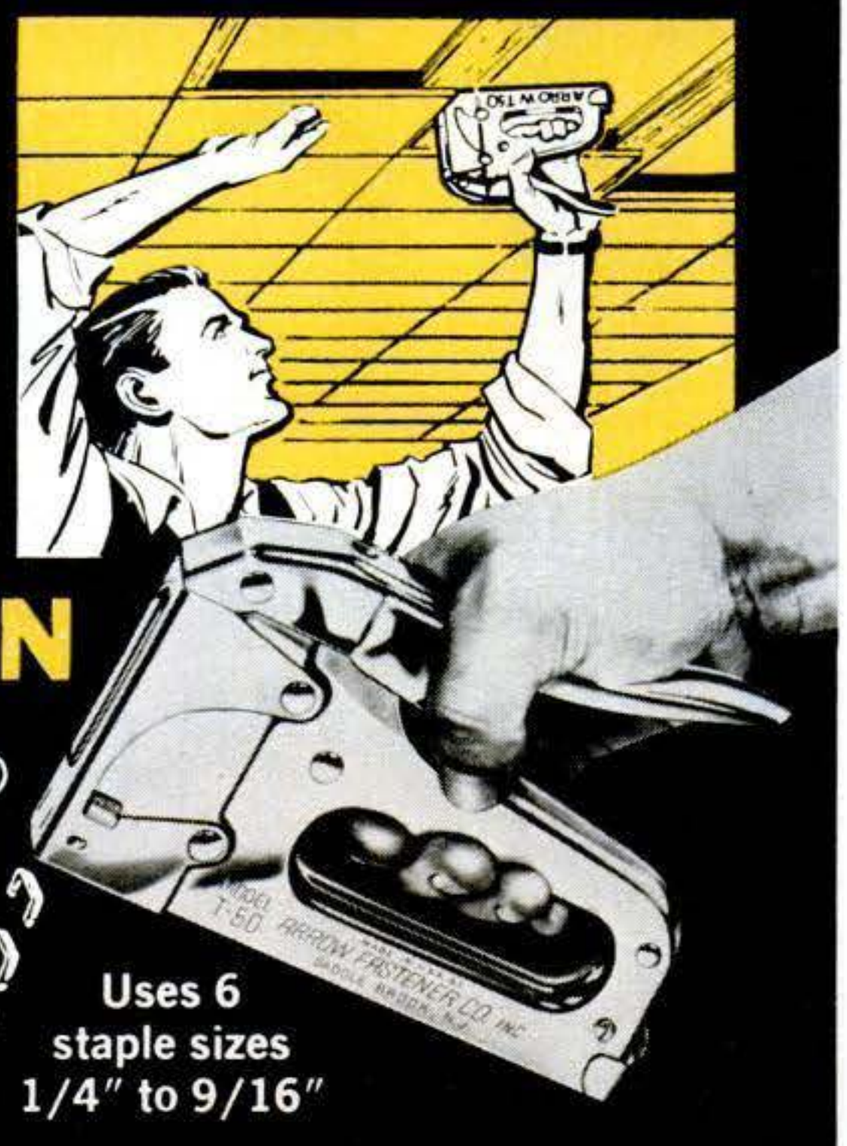

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Having driven diesel trucks a lot, I am sold on diesel engines for sustaining power and economy, and I talked our school district into buying two buses with D-478 G.M.C. V6 diesels, about a year ago. Well, I am now real embarrassed, for I have never encountered such vibration in engines in a couple of hundred thousands of miles of driving. The rpm drop-off rate is so fast, you barely have time to double-clutch to the next gear; and, at idle, vibration is terrific. The injector lines need constant attention to keep them tight enough to prevent leakage; even breakage. The factory rep said nothing can be done—it is just the nature of the engine. I don't agree. I believe a much heavier flywheel would bring this vibration down to a level equal with other diesels. Does G.M.C. put out a heavier flywheel for this model? What else could help?

J. R. CORNELL, Cottage Grove, Ore.

That model does vibrate pretty badly, and tends to do everything you mention. I don't believe there's room for a bigger flywheel; or, if there is, that it would solve the problem. The only help I know is a real good setting on the fuel-injector pump. My experience with that particular engine varies from horrible to very good—depending on the model and type of vehicle it is in, and the maintenance it gets. But I have also found there is a tendency to overrate this engine. At best, it is only 170 hp. In a big school bus, overloading the engine could easily be the cause of the trouble.

I purchased a used 1969 Chrysler, then subsequently discovered that all the tires were marked "Seconds." Exactly what constitutes a "Second"? Are they considered safe enough for a heavy car at highway speeds? The speedometer also reads 10 percent too fast at 70 mph. Would the tires be the cause of that?

LOU SMITH, Phoenix, Ariz.

"Seconds" are tires that are not up to specifications in some way, so sell cheaper. It is hard to say just how good they are—it depends on the reason for marking them, in the first place. There is no way I can tell you if they are safe. Hopefully, tire regulations will stop any unsafe tire from reaching the market. Tires can very much affect the speedometer. If they are smaller than specified, the wheels make more revolutions per mile than they should, and the opposite if oversize. But the tires may not be the fault; have your speedometer checked before you go further.

Some people tell me that every time you change to a different brand of oil, you have to change the filter, too. Is this true? Also, should the oil filter be changed every time you change oil?

V. ROMEO, Brooklyn, N. Y.

First—don't change makes of oil too often. It is better to stick to one brand. If you do switch, it's wise to change the filter, also. As to how often you should change filters, under regular conditions, here's how I see it: You cannot change too often; but if you wait until after 5,000 miles, I'd say you waited too long.

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"With my budget when the engine packs it in so do I."

Tom Davey's in racing for the fun of it. He's not a pro with a spare engine and a big fancy pit crew. He pays his own way. And he knows that a championship he's been chasing all year can go up in clouds of smoke — right out the tailpipe.

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Which is more than Tom can say for other racing oils he could name. Because he's come face to face with bearings that were the victims of oil breakdown.

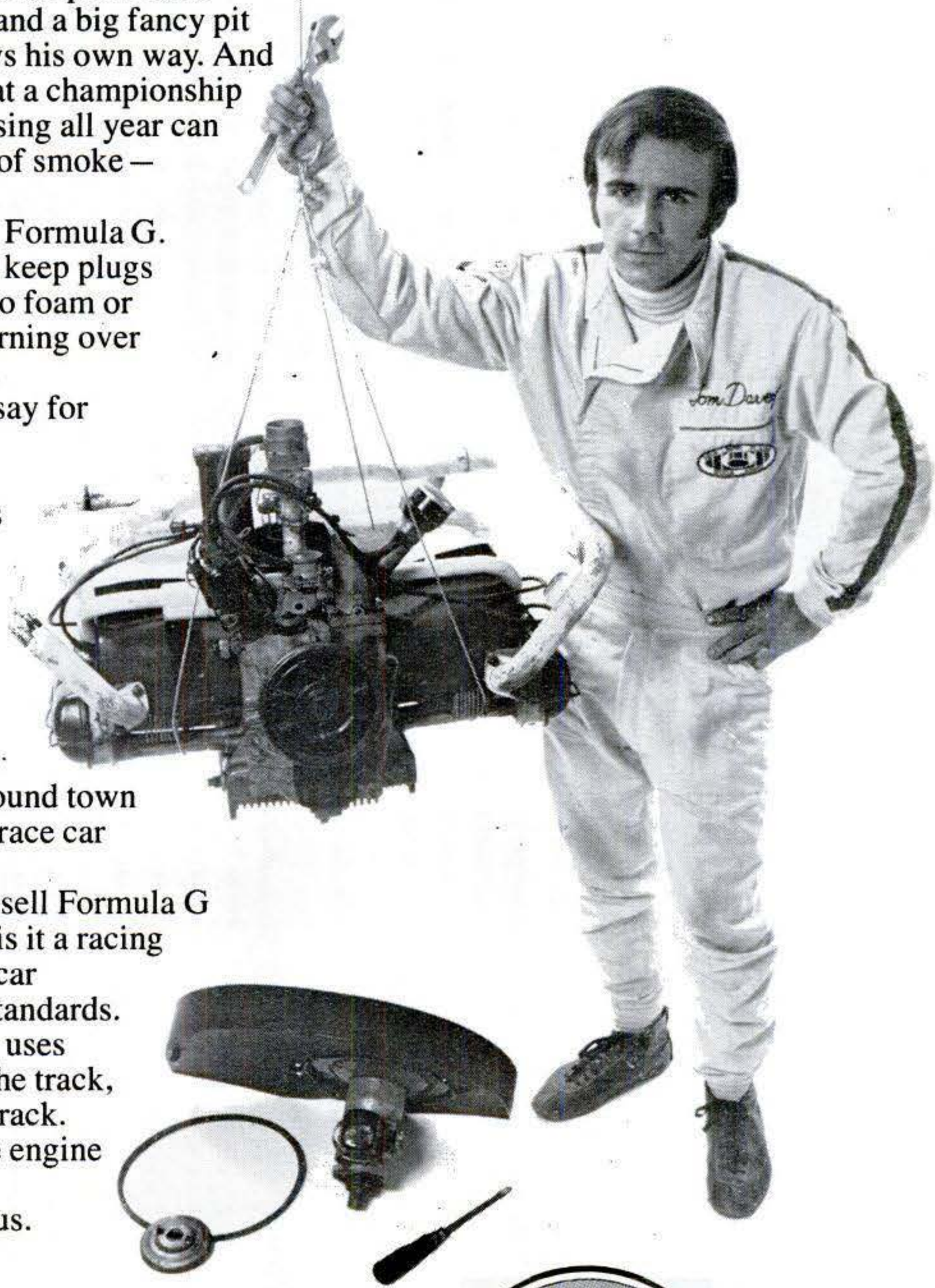
And that's why he switched to Formula G.

Not a bad reason for you to switch, either — whether you're driving a muscle car or the family wagon. Because chances are your oil is going to be running hotter around town or on the highway than the oil in a race car equipped with an oil cooler.

It's nice to know, too, that we sell Formula G at Gulf stations. Because not only is it a racing oil, but it also meets all passenger car manufacturers' new car warranty standards.

Tom knows. Which is why he uses Formula G in the car he drives to the track, as well as the car he drives on the track.

He knows that if he blows the engine in one, he loses the race. But if he blows it in the other, he rides the bus.



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Comparing the meter against one used by California highway patrol, author and patrolman calibrate it accurately.

PERSONAL-USE REPORT

Now... A Sound-Level Meter for $40

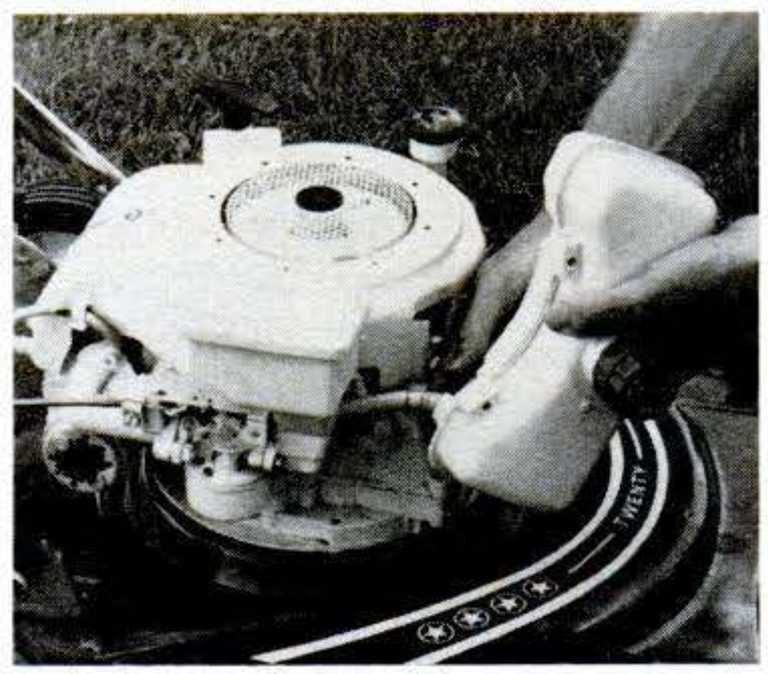
The high-cost barrier of sound-level meters has been shattered. The new Realistic meter (from Radio Shack, 730 Commonwealth Ave., Boston, Mass. 02215) sells for $39.95—and still competes with those costing $250.

To calibrate the meter, I compared it with one used by the California highway department. It showed a discrepancy of over 20 decibels. By turning the adjusting screw all the way in, I got it to within two decibels of the other one at 50 Hz, but no closer.

For measuring sound against sound—say, to balance the speakers of a PA or stereo system—the Realistic is excellent. Its range is 60 to 116 decibels.—*Jim Davis*

Low-cost Realistic meter has features comparable to $250 units.

One pull—and the author is ready to go with Tecumseh's new no-choke mower.



Lift-off plastic fuel tank mounts like a clip on the engine, so it's easy to dump gas before storage. Drain button on carb bowl frees residual fuel, prevents gumming.

PERSONAL-USE REPORT

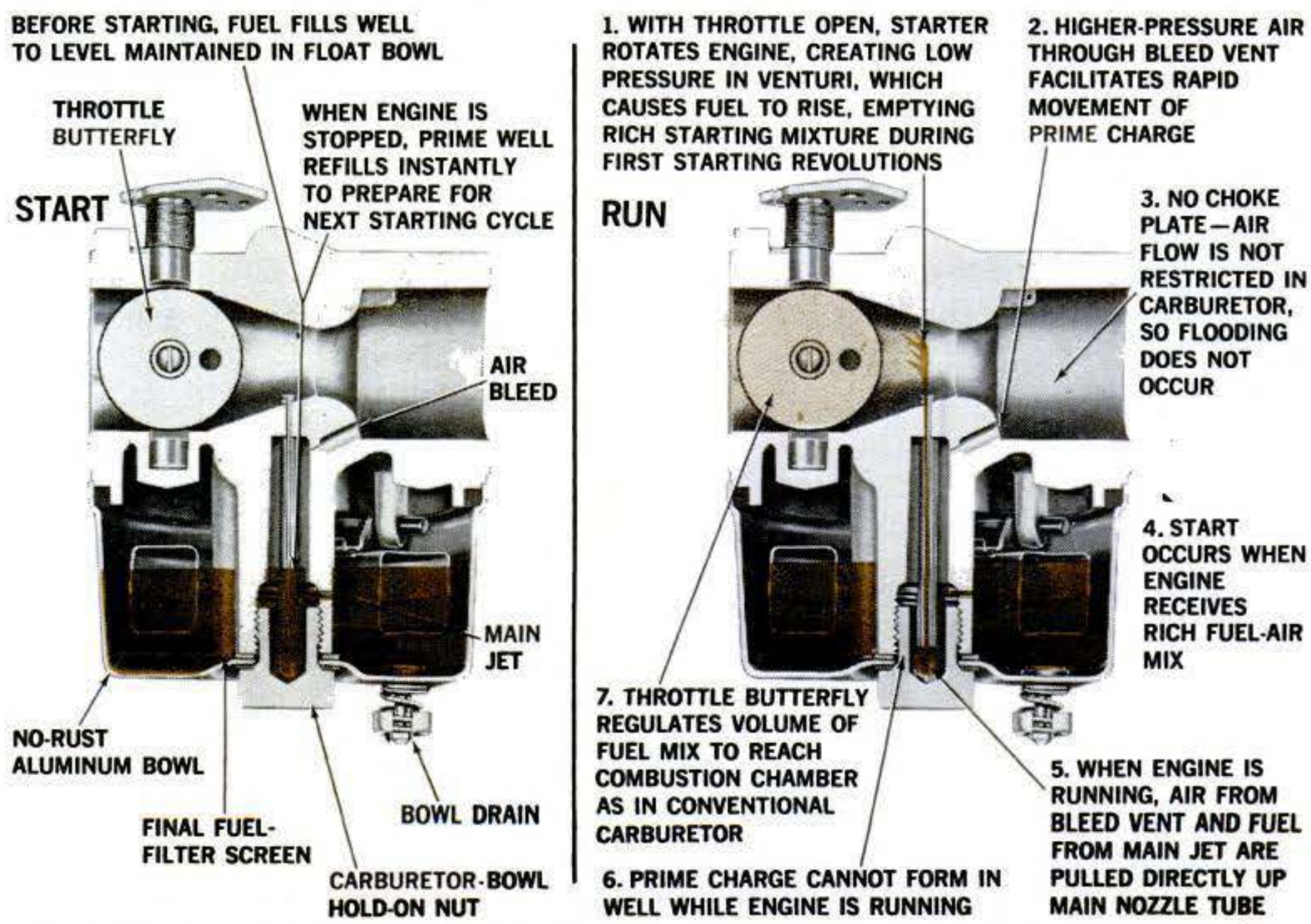
One Pull—You're Off and Mowing

First-pull starting claims are not new in the mower-engine industry, but Tecumseh's new chokeless carburetor seems close to hitting that target. Its design is novel—no choke, diaphragms, or adjustment needles. The carburetor used on the 3-, 3.5-, and 4-hp LAV series rotary mower engines has a built-in priming well.

My tests under intentionally abusive conditions could not prevent the engine from starting on one pull. For example, disconnecting the plug wire and vigorously pulling the starter rope often enough to flood a conventional carburetor did not prevent starting on a single pull when the plug was reconnected. I even packed the carburetor in ice and thoroughly chilled it. It made no difference.

The engine also has a unique air-cleaning system. A snorkel picks up reverse-flow air from the cooling fan where, it is claimed, centrifugal action provides almost dirt-free air. The polyurethane filter can be removed and cleaned without tools.

Internally, the upper main bearing and camshaft are pressure-lubricated by a positive-displacement oil pump. The governor is a mechanical-flyball type.—*E. F. Lindsley*



Schematic of carburetor shows fuel level and flow during start (left) and run (right).

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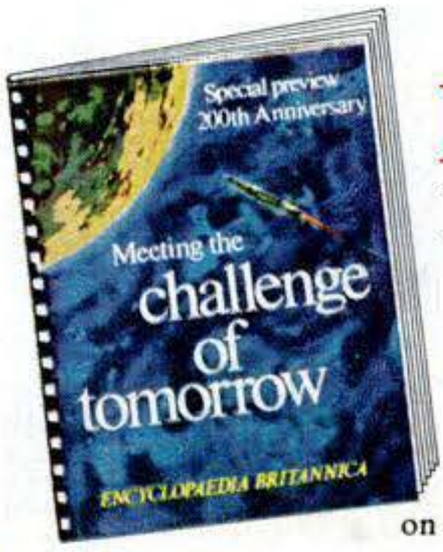

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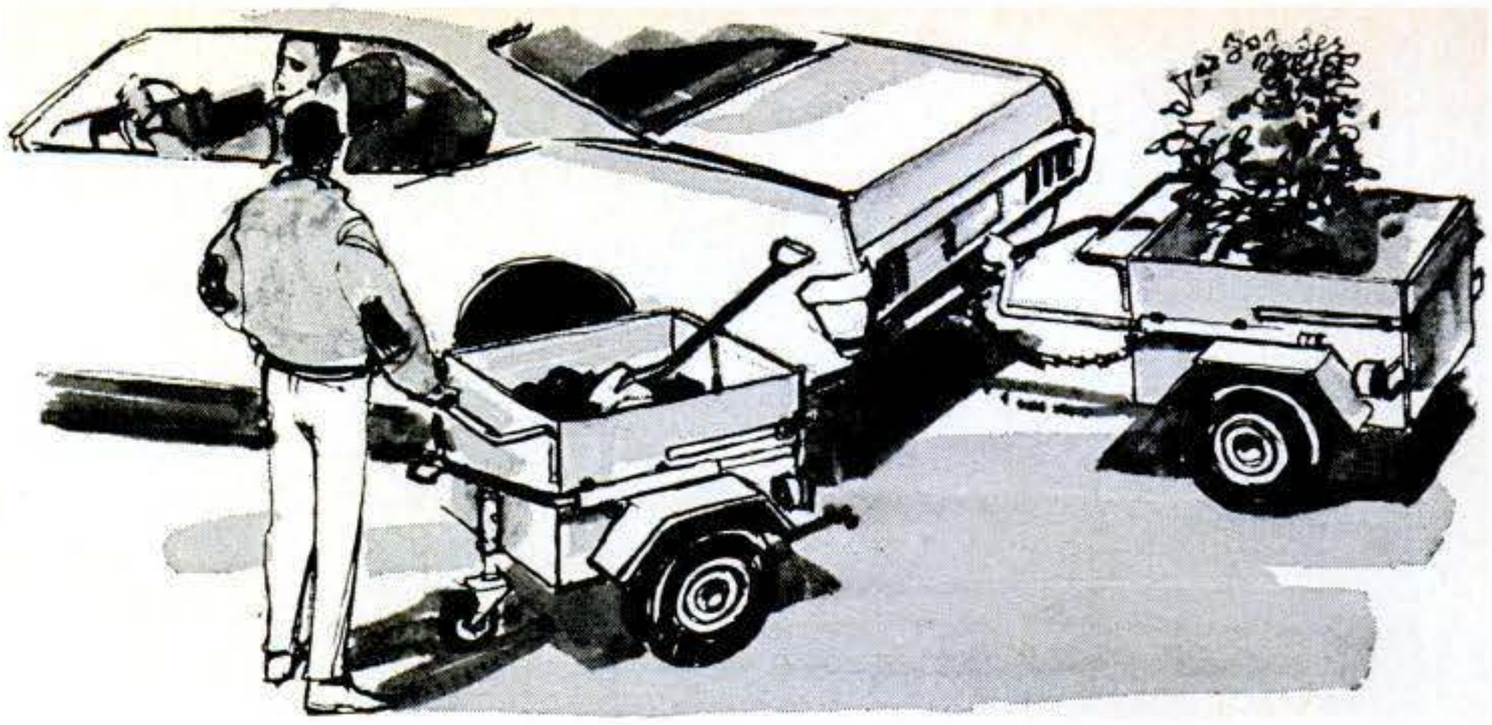
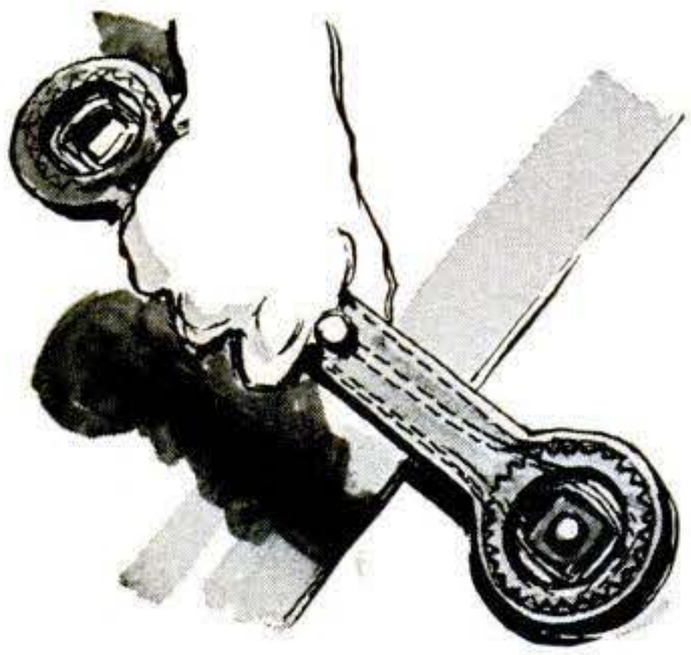
New Ideas from the Inventors

ILLUSTRATIONS BY DANA RASMUSSEN



Barrow hitches for long hauls. A slide-out trailer hitch on this recently patented hand cart would let you push or tow it, according to the requirements of the job. The caster wheel would slide down to help support the hand cart, retract when it was being used as a trailer. The cart's outboard end would hinge downward to simplify loading and dumping and to accommodate long loads.

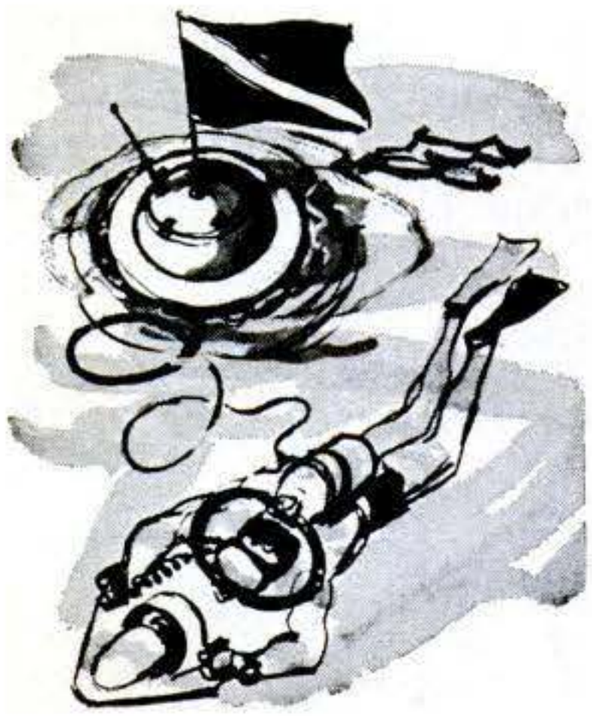


Ratchet wrench adjusts to nut. A flexible band running through a groove in the shank of this box wrench would adjust each end to fit different sizes. The shimming band could be pushed downward in the socket when its thickness was needed for extra grip, pushed out of contact with nut when it wasn't.

Rake folds for storage. You could get through big lawn-cleaning jobs faster with a rake designed to spread out wide in use and fold narrow for hang-up storage. The blades would be serrated on one edge, straight on the other. Sturdy wire stays would snap into a socket in the handle to spread the blades.

Razor counts shaves. If you find today's razors are better than your memory, you might let this razor keep count. You'd press a spring to zero a rotating counter ring. Each full opening would then advance the counter by one. Partial opening (for mid-shave rinses) would not affect the numbers.

Blind hinges into cab. You could set up a hunting (or photography) blind before your prey could get away if it folded up, like this one, out of the bed of a pickup truck. Set into stake racks in the truck's sides, pivots would let you flip the assembly onto the top of the cab. In travel position, it would overlie the truck body without interfering with normal loading.



Buoy powers swimmer. A skin diver could cover greater distances with less effort behind this electrically powered wing. In shallow water he could tether himself and the motor by power-line umbilical to a battery-carrying buoy. (For unhampered movement, he could wear a battery pack.) Switches and regulators would be located in the grips at back of motor housing.

The following patents have been issued on these inventions: **Trailer-cart**—*No. 3,443,268 to M. Symes, Tillamook, Ore.;* **Adjustable wrench**—*No. 3,413,878 to W. Mariner, Salisbury, Md.;* **Folding rake**—*No. 3,483,689 to H. Kabel, Toledo, Ohio;* **Shave counter**—*No. 3,440,999 to A. Saferstein, New York, N.Y., and J. Ross, Monsey, N.Y.;* **Hunting blind**—*No. 3,406,784 to G. Jones and T. Little, Dilley, Tex.;* **Swim propulsion**—*No. 3,441,952 to J. Strader, Brentwood, Calif.*

Copies of patents may be ordered, by number, from the Commissioner of Patents, Washington, D. C. 20231, at 50 cents each. To write to an inventor, if the address above is insufficient, address him (by name and patent number) in care of the Commissioner of Patents.

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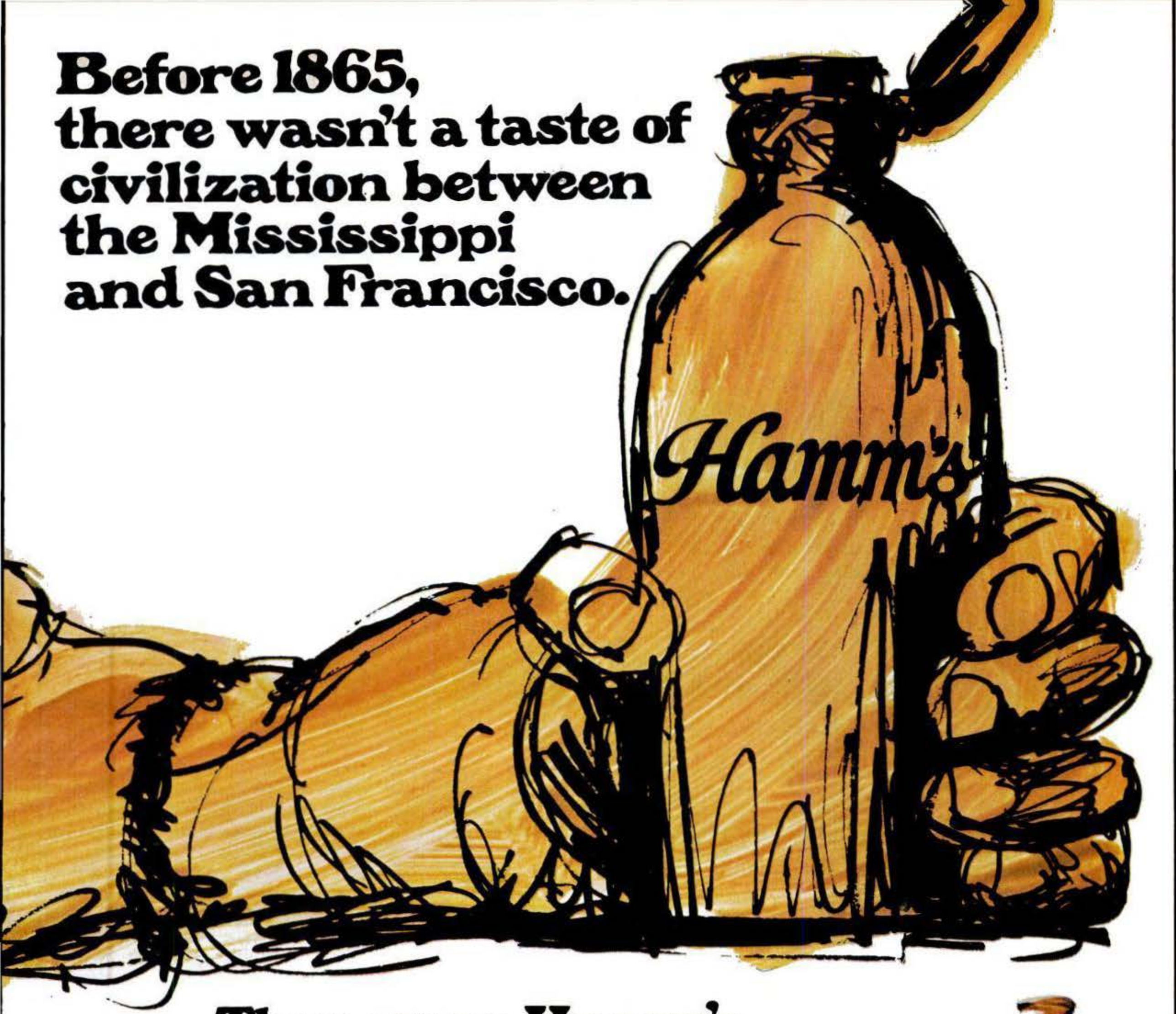
Before 1865, there wasn't a taste of civilization between the Mississippi and San Francisco.



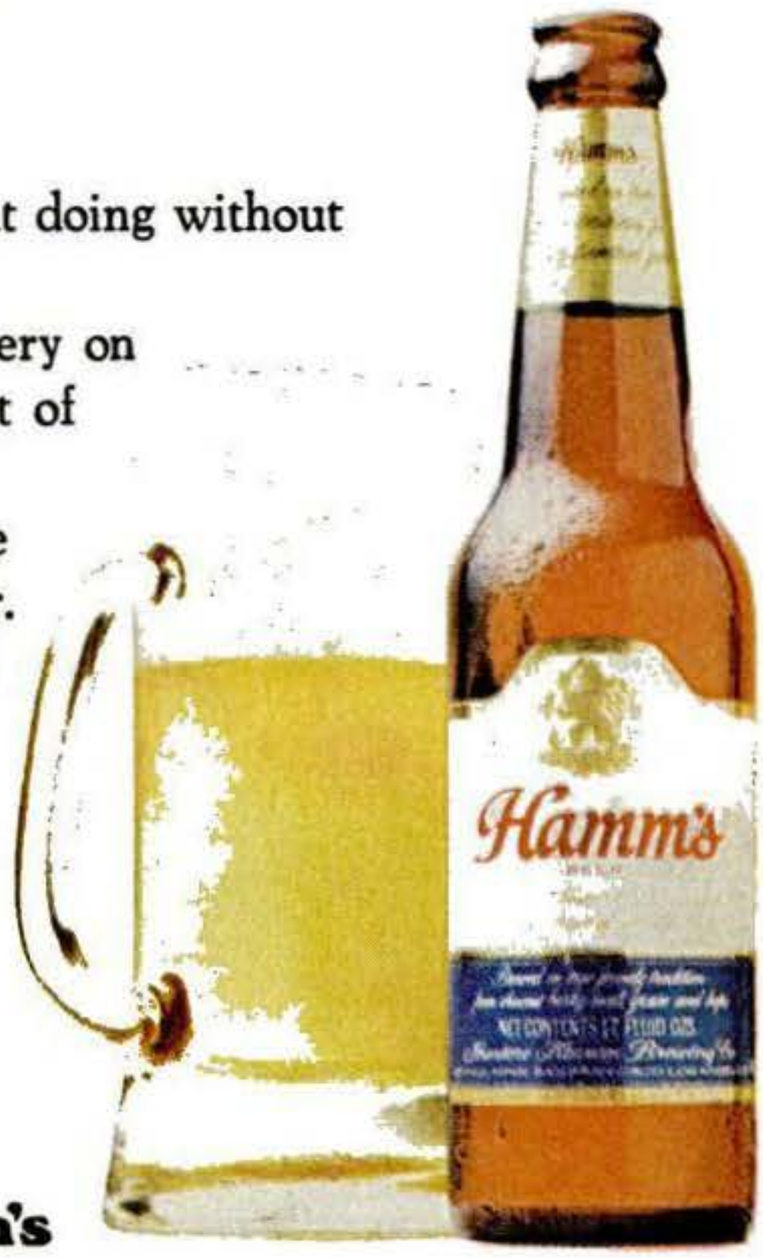
Then came Hamm's.

A frontiersman could get along without a hot bath. But doing without a decent beer was hard to put up with.

So when Theodore Hamm opened his tiny brewery on the edge of America's wilderness, his beer found a lot of ready takers.

Because there in the "land of sky blue waters" he had found the pure, icy water he had been looking for. The water best for brewing. And with it he brewed the frontier's first great beer—beer with a flavor that ran deep.

Today, the Hamm's brand of civilization spans the country. Because the flavor still runs deep. As deep as it did 105 years ago, when Theodore Hamm brought beer tradition across the Mississippi.



A beer is a beer is a beer until you've tasted Hamm's

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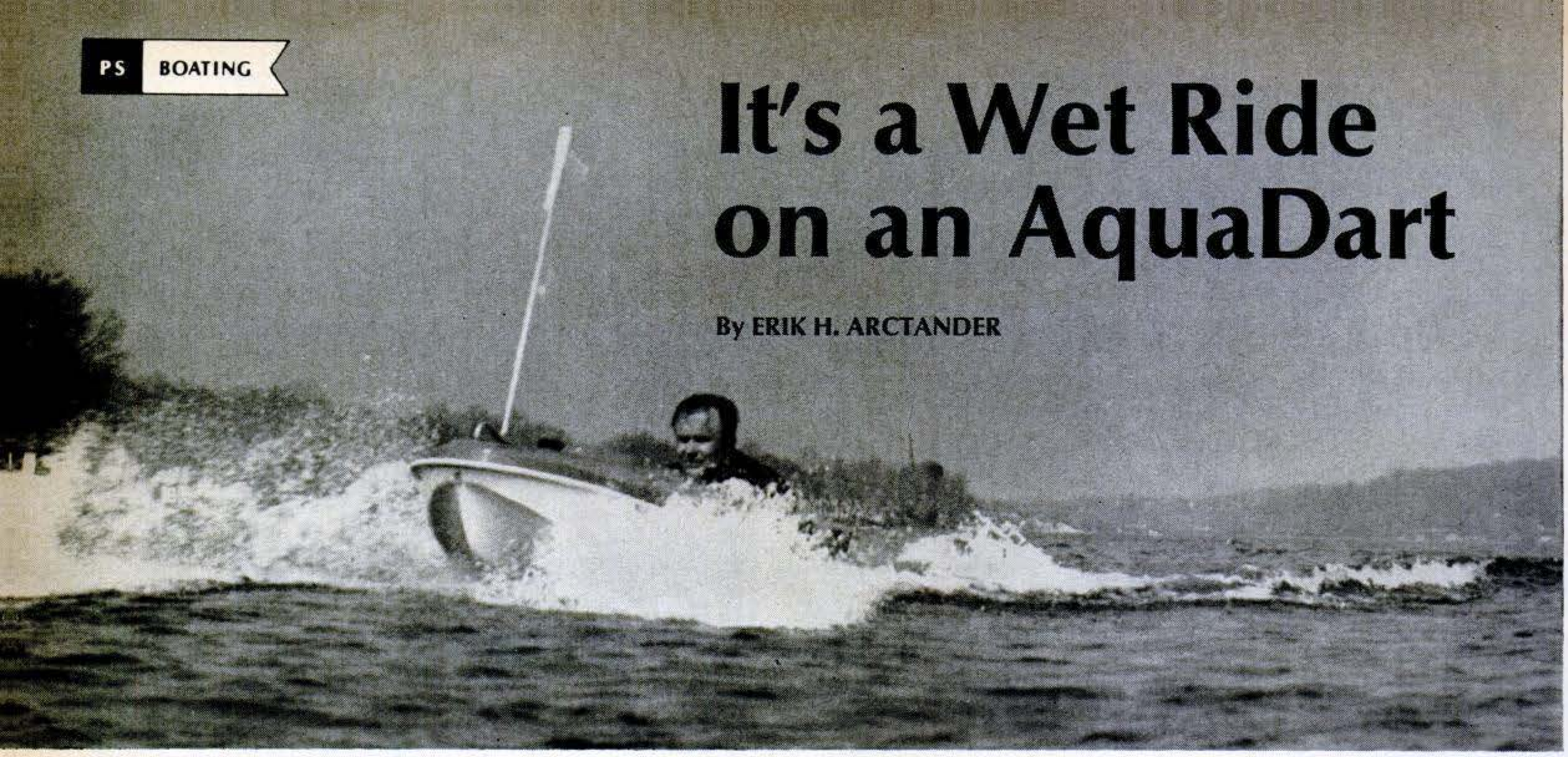
It's a Wet Ride on an AquaDart

By ERIK H. ARCTANDER



Twisting the AquaDart's throttle for the first time, says the author (above), is just like grabbing a moving whale by the tail.

20-hp OMC outboard drives the AquaDart. Engine's lower unit projects through the center of the hull and turns a three-bladed prop that's protected by a guard.

Your feet do the steering in this wild 25-mph craft that's half boat, half you

You flop down on the AquaDart, hitch yourself forward until your armpits fit into the notches on both sides. A backward pull on the two handles, and the engine's relaxed rumble instantly becomes a powerful snarl. In seconds you're skimming the waves like a runaway torpedo.

It's exciting, but uncomfortable and hard to steer at first. Your triceps feel sore, neck muscles ache from holding your head high; the unyielding control board presses upward against your legs. While you just hang on, doing nothing, the craft weaves slightly from side to side. At 25 mph you're running out of lake, so you dab a foot to one side and the AquaDart makes a wide, lazy turn.

Feelings mixed, you slide off the boat in waist-deep water for a rest. Fifteen minutes later, after some picture-taking, a strong urge to climb back aboard asserts itself. This off-again on-again behavior is common among riders, you're told.

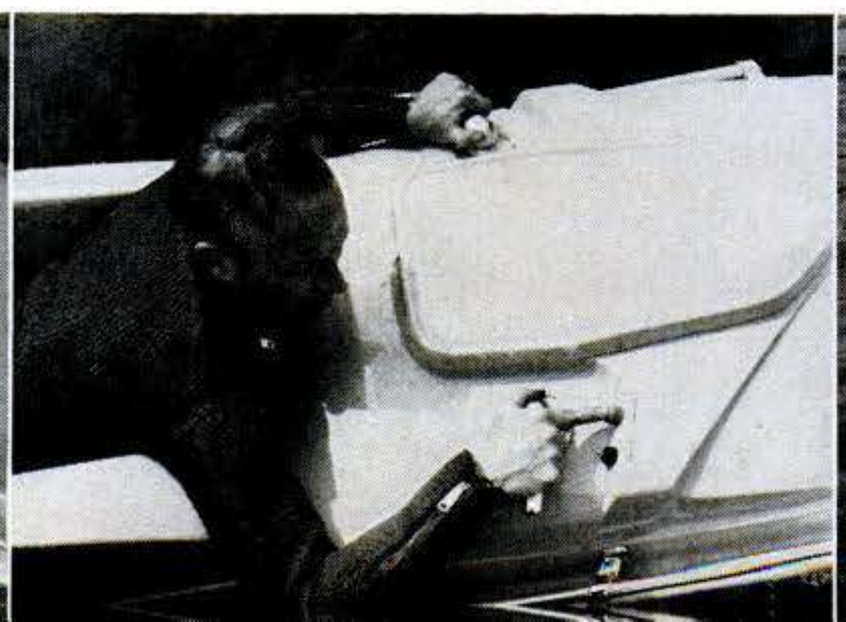
You're more at home on the third round and grab a handful of throttle. She leaps ahead, her bow steady this time. As the beach looms up, you back off on the gas, lean to the right, fling both legs to that side, and shove down on the control board with your right knee. She heels slightly and starts to swing hard right; half-way around, you open her up again and she completes a sharp U-turn.

Now you find it easy to carve figure-eights in the water, hold a circular course tight enough to make you dizzy, slam through your own wake at full speed. It's exhilarating and exhausting, manhandling this 190-pound fiberglass sport boat.

Leisuredyne, Inc.—maker of the AquaDart—hopes that the 25-mph top speed and $995 f.o.b. price tag will attract thousands who find the popular sailboards too tame. They've started AquaDart Clubs of America to promote group exploring and racing; developed special trailers and clothing, too. Leisuredyne's address is Box 1004R, 166 Ridgedale Ave., Morristown, N.J. 07960. PS

Opening the hatch cover reveals the outboard's powerhead, ignition key, battery. Gas tank, forward, holds three gallons.

To start, you flip on a choke switch, jab starter button with throttle half open. Left handle, a safety switch, must be on, too.



As it takes off, AquaDart's control board swings up under rider's legs. He steers by shoving down with his knees and leaning.

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PERSONAL-USE REPORT

Here Comes the Spectre

Heath's first R/C race-car kit hits the fun market

Before firing up the engine, author checks controls. Body snaps over bumper of steel chassis.

Finally—there's a rugged, yet simple, model R/C "car for the masses." Heath Company's price for the Spectre kit (GD-101) is probably the lowest on the market—$49.95. And its matching kit radio system can be used on model planes and boats, too.

The GD-57 radio system can handle three servos: two via sticks on the transmitter, a third by the lever on the case back. Two servos come with the GD-57 kit, which sells for $129.95. Extra servos are available, but many system parts are interchangeable with those in the Heathkit five-control GD-19 R/C system. Heath R/C systems come on all R/C frequencies in the 27-, 50-, and 72-MHz bands (FCC licenses required).

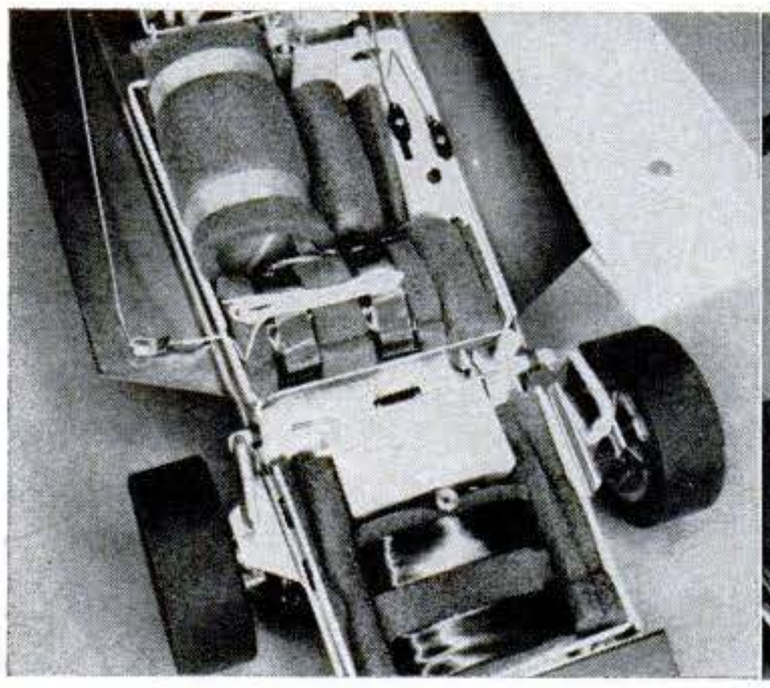
Putting 'em together. It took me about 18 hours to build the radio system, and about 13 hours for the car. You assemble the transmitter first. Its parts are large and the assembly isn't "tight." The receiver is next; parts are smaller, more numerous. Servos are last, their printed circuits being rather crowded.

To assure good soldering, Heath furnishes a high-grade pencil-tip iron and correct solder. The transmitter features a fully collapsible antenna, charger for transmitter and receiver, nickel-cadmium batteries, and a meter to monitor output and charging. (The transmitter meter handles all radio tune-ups, too.) Batteries hold a charge for 3½ hours' operation.

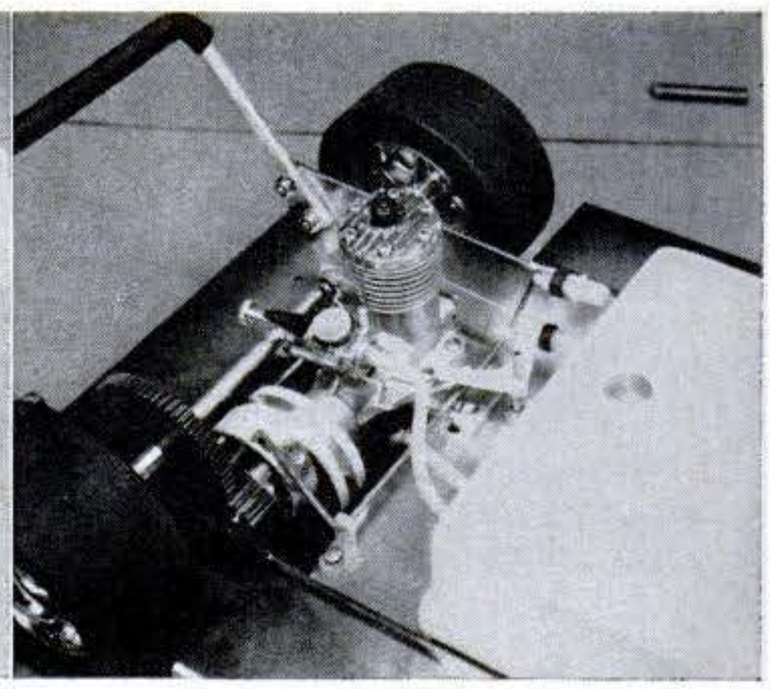
The Heath Veco .19 engine ($19.95) comes ready to run, but it needs an hour of break-in with an air propeller before you install it.

You start the engine with the body removed from the chassis. Starting is easy, but I recommend an electric starter, anyway. Spectre was designed expressly for the Veco .19 engine and the GD-57 radio systems, but it will take other engine and radio kits.

Spectre is a ⅛-scale model GT sports type. It weighs about 7½ pounds, has a 12-inch wheelbase, and is almost 20 inches long. The four-ounce fuel tank provides 15-20 minutes' running time. Top speed, Heath says, is 25 mph, but it seemed a lot faster to me. It never overturned, even at full throttle, but there were many spinouts—spectacular but harmless. Heath claims great success in organized model-car races with Spectre.—*Howard G. McEntee*



Wrapped in thick plastic foam, components in equipment box are protected from vibration and shock. Servos are unwrapped.



Sidewinder engine installation has vane in exhaust stack pointing rearward. Carb has two fuel adjustments for low speeds.

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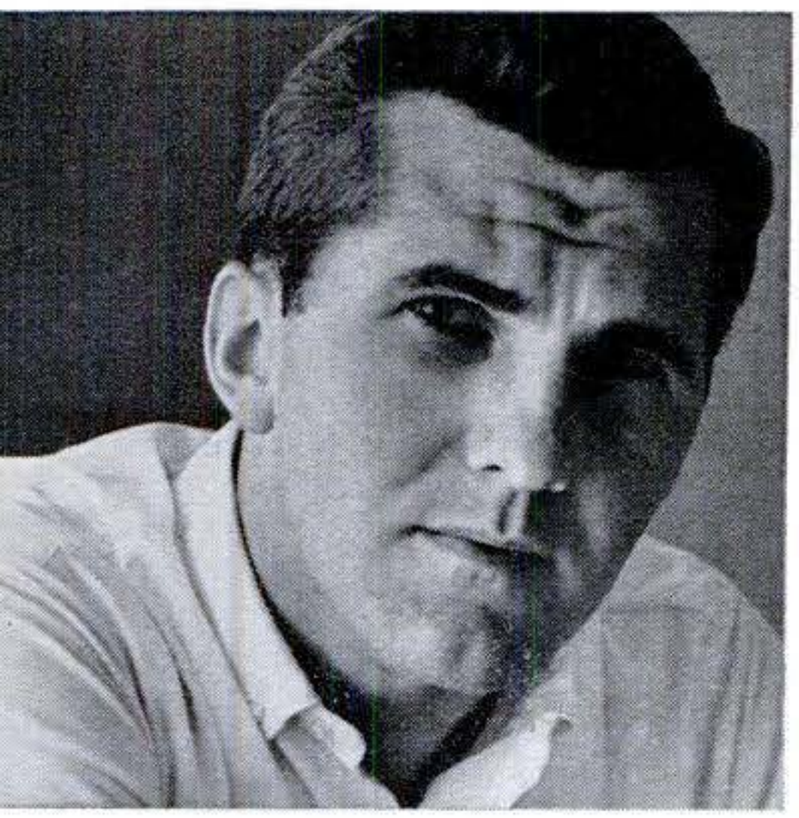
Are you missing out on the extra pay of an I.C.S. graduate?



Recently we mailed out a questionnaire to a group of our graduates, two years after they had received their I.C.S. diplomas.

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Recreation Roundup

...on the move with PS

By HERBERT SHULDINER

All-season buggy fits in car trunk

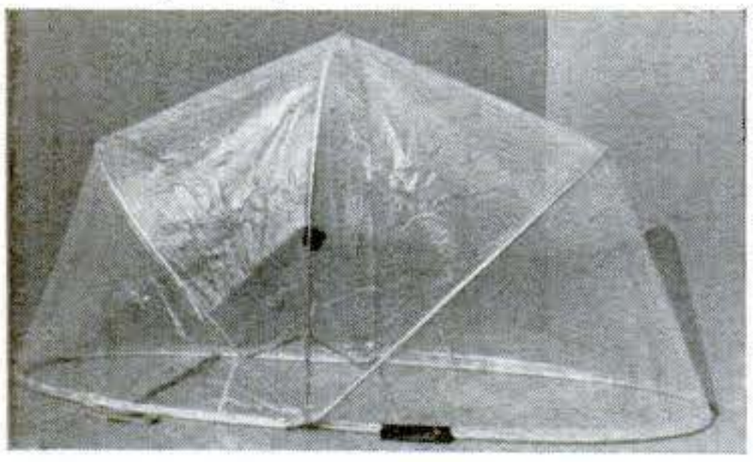
Looking for something new? Try the Dunecycle for kicks. This three-wheeler will even shed its front wheel to take a ski for snow-sport fans. It gets top speed of 30 mph out of its five-hp, four-stroke engine. Drive is through a jackshaft arrangement. Price: $460 from A.P.E. Products, 13727 Excelsion Dr., Santa Fe Springs, Calif. 90670.

Cure for camper slump

Major camper manufacturers experienced a disappointing sales season last summer, so look for some radically new changes in the '71 models. One spokesman for a major manufacturer tells PS that his company is making more changes in its '71 models than in all the years it has been in business. His competitors have the same plans.

Meanwhile, motor homes continued to display surprising growth last season, while other types of units were slumping. Lower-priced units like Winnebago's Renegade series (above) have opened a new market to motor-home manufacturers. The Renegades are priced from $5,995 to $7,675. Winnebago claims it has achieved this price breakthrough without cutting quality through production-cost cuts in its new highly automated factory.

Cover-up for sportsmen

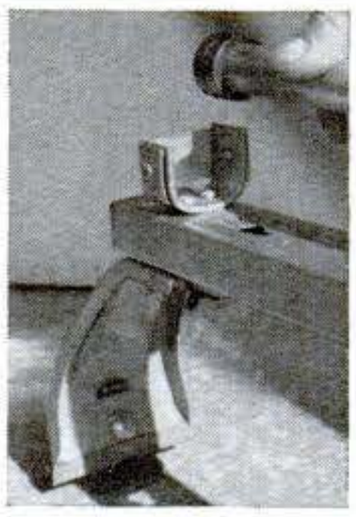


This versatile shelter is a year-round protector against wind, snow, and sand. Big enough to accommodate two, the Kabbanette folds out in a jiffy to serve as an ice-fishing hut, hunting blind, or refuge from winds at the beach. Tough plastic over a tubular-steel frame, it weighs only 18 pounds. It's made by Daybreak Dynamics, 913 Elm St., Wheaton, Ill. Price is $45.

Exclusive club

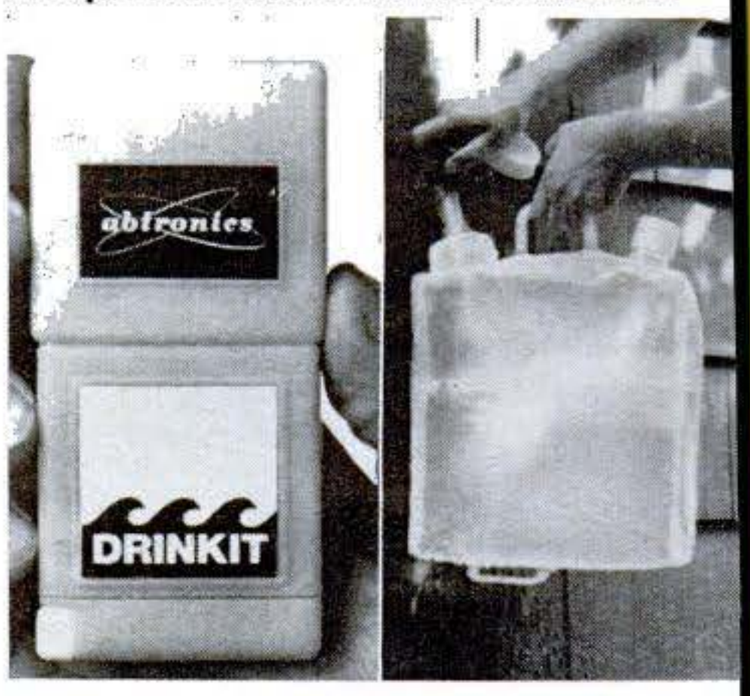
In our era of supersonic speed it hardly seems that 100 mph is very fast. Yet there are less than twenty persons in the U.S. who have traveled that fast on water using outboard power. Evinrude Motors, which holds the world outboard record of over 131 mph is forming a club to honor anyone who can top the century mark with an outboard, provided he does it on a certified course and the time is verified by the American Power Boat Assn. If you want to be exclusive, here's a fast way to do it.

Handy aid for canoeists

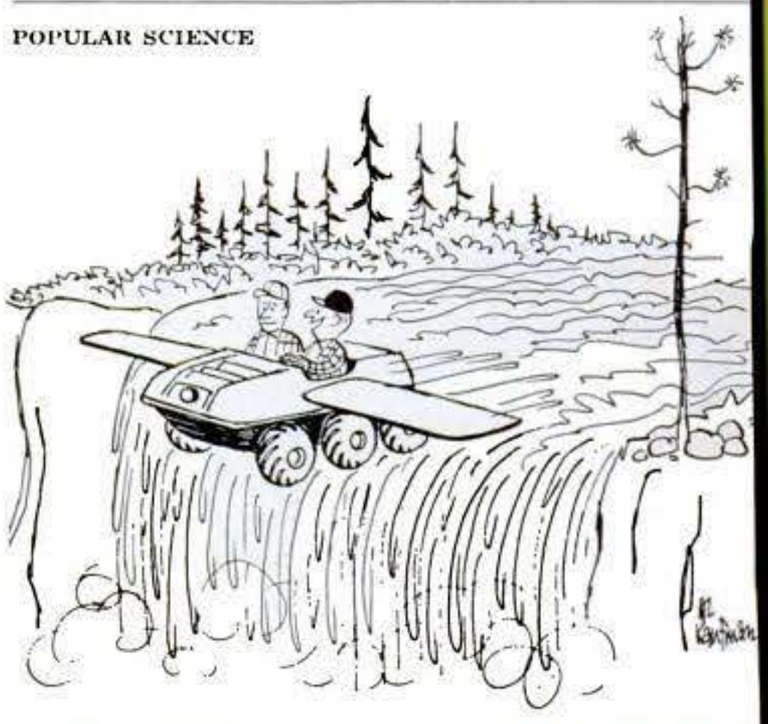


Reader K. J. Molinaire of Roselle, Ill., passes along a nifty homemade system for easy canoe loading. He built this roller bar out of two 6" lengths of broom handle whittled down to fit into the ends of a length of 1" electrical conduit. Two roller-skate wheels were attached to the wood ends with 3"-by-¼" lag bolts. The roller receptacles are made out of a 4½" length of 1"-by-⅛" bar stock to form a U whose sides are 1½" apart. The receptacles are bolted on any standard-top carriers. Caution: Be sure the outside diameter of whatever size bearings you use are wider than the conduit; otherwise the loaded roller might touch the car roof.

Antipollution aids for outdoorsmen



Water troubles? The battery-powered pocket water purifier (left) is reported to convert a pinch of table salt in a tablespoonful of water into a solution of "free chlorine and other bacteria-destroying compounds." That's enough to purify a gallon. Drinkit costs $10 from Abtronics, PO Box 712, Livermore, Calif. 94550. The Port-A-Jug (right) is a collapsible plastic container that carries 2½ gallons of water and stores flat when empty. Also handy for carrying foods and ice cubes. It's made by DeWitt Plastics, Auburn, New York 13021.



"How about this! An ATV and then some!"

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State troopers do not endorse products.

But this one thinks Lifesaver Radials are too good not to be talked about.

You may have heard lately about a new kind of tire. A tire that's 33% stronger—that gives 30% better mileage—than even our fiberglass-belted tire.

A group of people who've had good things to say about it are state troopers . . . highway safety experts.

This trooper's face is masked, and his uniform disguised, because neither he nor his state will lend their names to any commercial product. But read what he has to say.

"I was off to the side when this guy raced past me. I floored it to catch up. And there I was going into a double curve—Deadman's Curve—at 115 miles an hour. But I never swerved an inch out of my lane. It was like riding a rail.

"After that, I'm getting a set of these radials for my own car. I have good reasons . . . my wife and kids."

You can hear the same kind of story from troopers across the country now riding on B. F. Goodrich Radials. Exactly the same tires you can buy. You'll seldom need the maximum performance troopers need, even for short periods of time. But it's nice to know these tires can deliver it.

Our newest radials are called Lifesavers. They're made a whole new way with Dynacor® Rayon Cord. So they corner better. Take curves better. Stop quicker. They handle better and run cooler at high speeds than fiberglass tires . . . even our own.

Lifesavers are the safest tires we've ever made. They're the tires your life should be riding on.

The New BFG Lifesaver Radials.
Your life should be riding on them.

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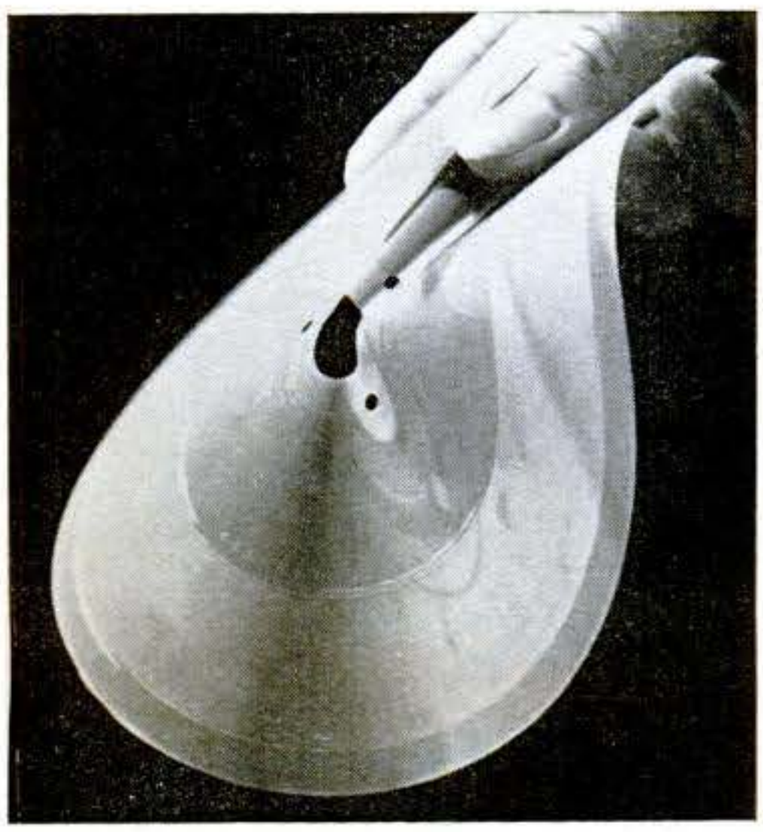
That's no ordinary phonograph—it's producing the TV picture on the set behind it.

VideoDisc Sets Record for Grooviness

Pressed into the filmy plastic audio/video disc below is a groove so fine it makes 10 revolutions around the record in a band only as wide as a human hair. In a band one inch wide it makes the rounds over 2,000 times. This compares with about 25 revolutions for an LP record.

Why so fine? Simple—it takes a lot of groove to produce the 25 TV pictures per second standard on European TV receivers. Five minutes of program material requires almost four miles of groove; it has to be fine to fit on the record.

The record is part of a new system capable of recording TV and synchronized sound on a disc. It was developed in a joint effort by AEG-Telefunken and Teldec, two large German electronics firms.



Filmy plastic disc has miles of groove, but only a few seconds of program material.

INSECTICIDE DISPOSAL: The Heat's On

Getting rid of dangerous insecticides is a new national problem. Can we burn them up?

Now that we've discovered the tremendous problems certain pesticides —DDT, aldrin, endrin, and heptachlor, to name a few—can cause, we are being faced with still another problem: How are we going to get rid of the stuff? Dumping it down the drain or throwing it into a fire doesn't help; it just moves the problem to a new location.

The state of Massachusetts, first to outlaw a long list of pesticides, including DDT, is also one of the first to hunt seriously for suitable disposal methods. One prime contender for the job is a superhot incinerator made by Thermal Research & Engineering, of Conshohocken, Pa.

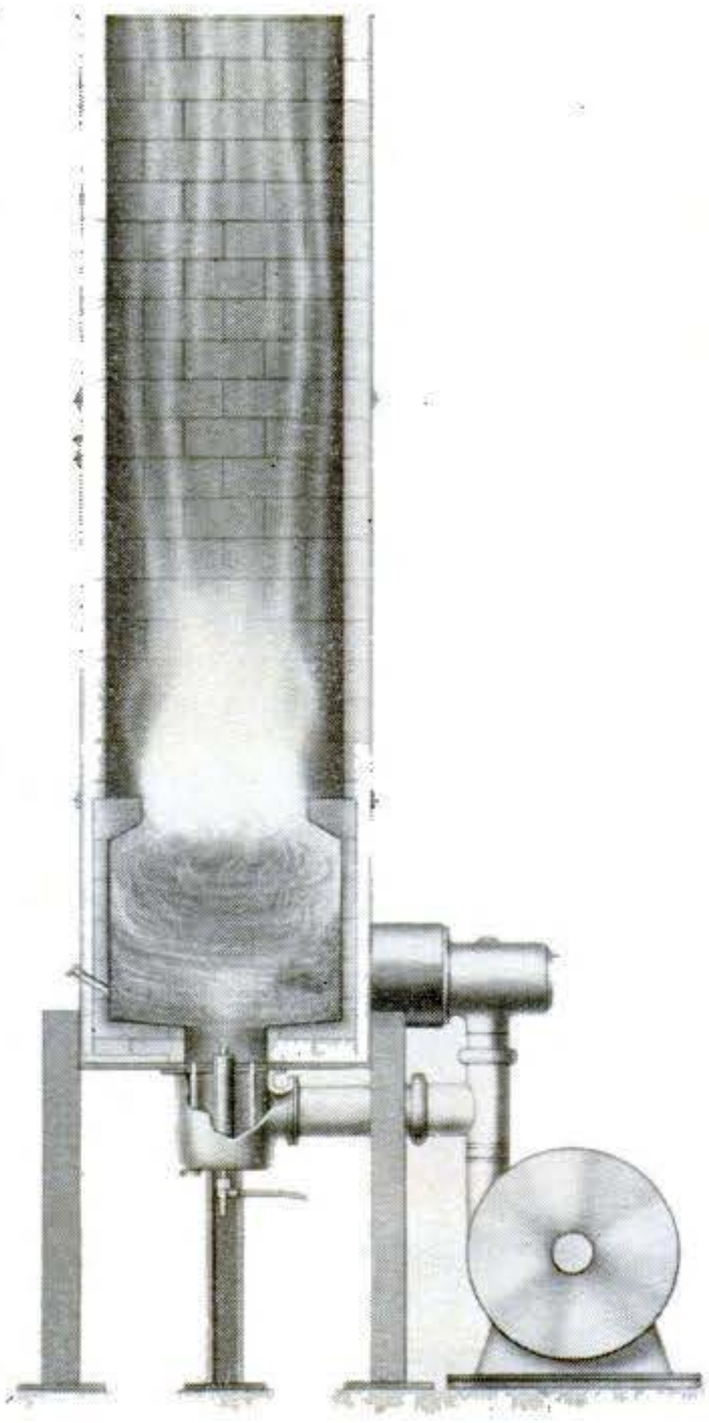
The prototype currently being studied by Massachusetts health authorities is adapted from incinerators originally designed to destroy dangerous industrial wastes.

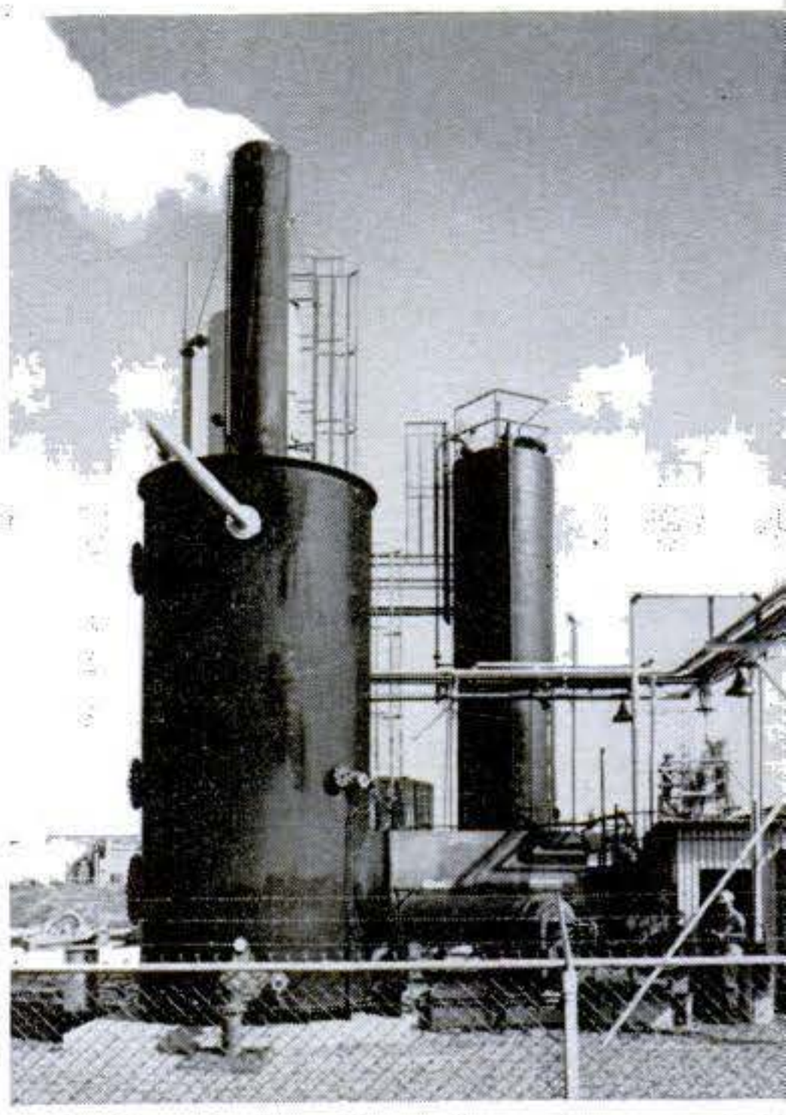
The basic principle behind the incinerators is this: Water solutions of the pesticides are injected into a high-temperature gas flame firing tangentially into a cylindrical burner. The 1,800°F to 2,000°F flame is hot enough to destroy most but not a condemned bug killers.

Since many of the problem pes cides are chlorinated hydrocarbo incineration produces its own tox byproducts, called tail gases. To g rid of them, the incinerators a hooked into giant scrubbers. Chl rides and fluorides are converted in their corresponding acids by caref balance of the incinerator's flam The acids can then be easily absorb in water.

At present, however, there are pesticide disposal facilities in ope ation. What do you do with that ha can of DDT sitting on the shelf your garage? Many states are settin up collection stations where you ca turn the chemicals in for disposal a later date.

In Massachusetts, citizens ha turned in enough of the stuff fill an ammunition bunker 120 fe long, and they're working on a se ond. Until we come up with a foo proof disposal system, the collectio and storage of the chemicals is ou best alternative.





Incinerator/scrubber above is one of th designs used to destroy industrial waste it could be converted to handle pesticide At left, a typical design injects pesticid from below into a whirlwind of flam created by an external gas burner at botton

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Shaves time.

This is the shave cream to use for that dreaded morning rush hour shave (when you shave faster than you should—without giving the lather enough time to really soak in).

Why? Because it heats up right under your nose. And takes less time to soften tough whiskers than ordinary cold shave cream. Making it entirely possible for you to get a close, comfortable shave in the morning. And still catch the 7:47.

The Hot One—when you shave too fast for comfort.

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Two-way radio for all cars? To cope with highway emergencies, that's the prospect resulting from recent FCC landmark ruling

New Help for Cars in Trouble

By RON BENREY

Suppose you're driving along a lonely stretch of highway on a rainy night. Suddenly, what had been your spare tire blows out. You're miles from a phone. How do you get help?

Before long, most cars on the road may carry the means of solving such emergencies—a simple two-way radio that several car makers are preparing to offer as a low-cost option when you buy a new car.

Two-way radio in every car? That's the possibility raised by a recent landmark rules change of the Federal Communications Commission for citizens band radio. As a new-car option, the radio would be there simply to protect you—like seat belts.

Right now over a million cars—about one in sixty—are equipped with CB transceivers. Countless other drivers slip CB walkie-talkies into their glove boxes before they take to the highway. The number should skyrocket in the months ahead.

Why the auto CB boom? Because CB Channel 9 is now a full-fledged emergency communications channel, set aside specially to help accident and disaster victims, and other motorists in distress.

Last Spring, the FCC decreed that after July 24, 1970, Channel 9 (one of the 23 authorized CB frequency bands) could only be used for:

- Emergency communications involving the immediate safety of life of individuals, or the immediate protection of property, or . . .
- Communication necessary to render assistance to a motorist.

Up until the new ruling, Channel 9 had ordinary status, and could be used for routine communication, although many CB'ers voluntarily treated 9 as "the emergency channel." Now, though, the chit-chat and "rag-chewing" are positively banned. Violations are punishable by stiff fines. When you transmit on Channel 9, you'd better have a good reason. For example: You've been involved in an accident and need help; or you've happened onto an accident and you want to notify the authorities; or, your car is out of gas on a bridge.

Who's listening? When you call for help, thousands of volunteers across the country will hear. The Electronics Industry Association estimates that there are over 100,000 public-spirited CB'ers who monitor Channel 9, listening for any emergency calls.

Over 40,000 CB'ers belong to a national organization called REACT (for *R*adio *E*mergency *A*ssociated *C*itizens *T*eams), members of 1,500 teams. REACT is sponsored by the General Motors Research Laboratories, and its team members actively listened to Channel 9 long before the FCC ruling gave it official status.

REACT National Director, Henry B. Kreer, reports that REACT team members last year provided emergency communication for over 1,000,000 local emergencies, including almost half a million auto accidents.

Essentially, REACT members, and non-affiliated monitors as well, serve as voluntary links between emergency victims and the proper authorities—police, fire department, highway patrol, Coast Guard.

This past summer, a unique experiment was begun in Ohio: The State Highway Patrol established monitor sites of its own in several patrol posts throughout the state. Thus, in many areas, stranded motorists or accident victims equipped with a CB set will be able to reach the Patrol directly, as well as via the state's 60 REACT teams. Patrol Superintendent Robert

[*Continued on page 129*]

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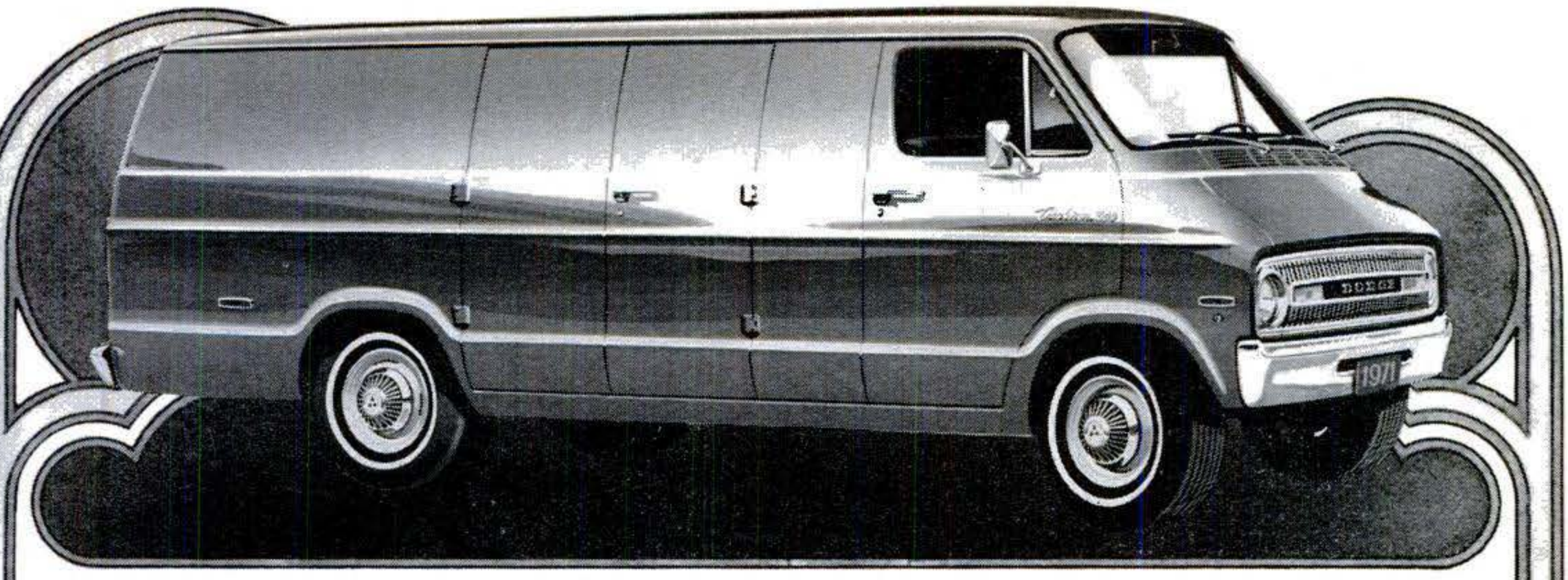
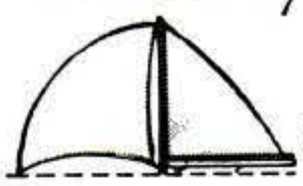
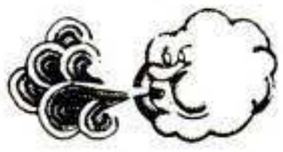


THE NEW DODGE MAXIVAN TRADESMAN

will carry a 12-foot sailboat , plus its mast  , a living room-size roll of carpeting , a snooker table , or a full-size alligator , under cover, and still give you all 31 features the other **Dodge Strong Box** models do. There's only one way to get power steering and Fresh Air air conditioning  in a compact van, and that is to buy a Dodge. Go ahead, call it the **world's** **biggest compact van**. Because that's what the Dodge Maxivan is.

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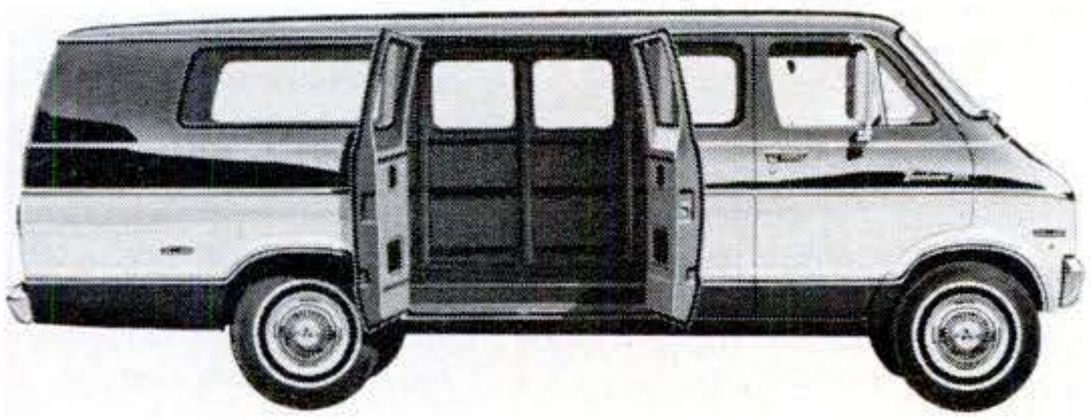

NEW DODGE MAXIVAN STRONG BOX

Dodge Trucks

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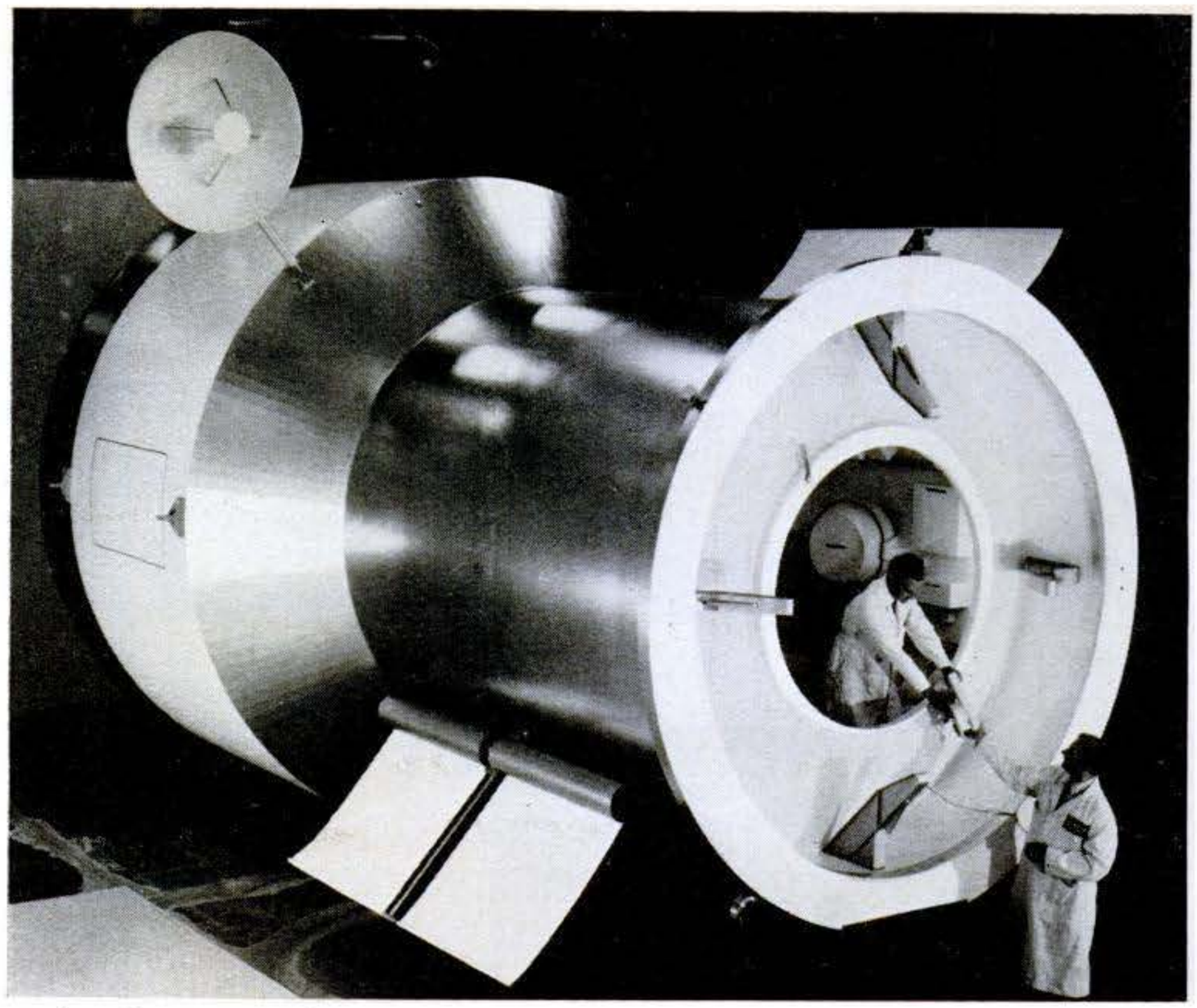
Science Newsfront

Last-minute news and notes to keep you up-to-date

By ARTHUR FISHER



A place for way-out future astronomers?

The late 1970s may find this free-flying astronomical observatory aloft. In this Martin-Marietta mock-up, technicians are at port where craft would dock to orbiting space station. Three-meter telescope would attach to other end. At left are solar array panels (for power) that unroll like window shades.

Electric power in hot water

A vast "hot ocean" that could yield 15 times the energy output of Hoover dam has been discovered beneath California's Imperial Valley. Such fields are called "geothermal," because they form when heat from the Earth's interior reaches cold subterranean water, turning it into a seething cauldron at more than 500 deg. F. Steam from such sites often vents to the surface, and is being used to generate electricity in Mexico, Iceland, and elsewhere, including California.

The University of California's Dr. Robert Rex said that the source, which extends over a 1,000-square-mile area, could generate more than 20,000 megawatts of electricity annually—enough to meet most of Southern California's power needs—for at least 30 years.

Accelerator built for two

The world's highest-energy Van de Graaf accelerator system has been successfully tested at Brookhaven National Laboratory. The system uses two electrostatic accelerators in tandem to attain its great energy—30 million electron volts for hydrogen ions. Each of the "twins" is sealed in a 140-ton steel tank. In the photo above, scientists inside one tank are inspecting the 10-million-volt terminal in the center of one of the 80-foot-long accelerators. The rings you see are used to distribute the 10 million volts evenly from the terminal down to zero volts at each end.

The Brookhaven system can be used to accelerate almost any kind of negatively or positively charged particle man is capable of producing. This makes it extremely versatile. And because the energy gain with heavy ions is very large, it will be possible to fuse one type with another, creating entirely new radioactive nuclei, which may well be extremely valuable in medicine and industry. Says Brookhaven's Director, Dr. Maurice Goldhaber, the accelerator "brings a new dimension to the study of the micro-world of the atom."

RUM go on the ocean floor

It may look rum, but it works. That's the verdict on RUM—the Remote Underwater Manipulator. The new seafloor vehicle has completed one phase of trials off the California coast with flying—or at least streaming—colors. Built by the Scripps Institution of Oceanography for the Office of Naval Research, RUM looks like a tank that has suffered an information explosion. The tracked vehicle is festooned with dolly- and boom-mounted TV cameras, binaural listening hydrophones, scanning sonar, an acoustic ranging device, an echo sounder, two light reflectors, and a long, jointed manipulator arm and hand that can exert 50 pounds of force in any direction, or lift loads of 1,000 pounds with a hook.

RUM has been tested both in shallow water and at 3,300-foot depths. It is carried to its working position on the surface in a 45-foot-square Oceanographic Research Buoy (ORB) and then lowered through a well by a 10,000-foot tether cable. As the monster crawls along the sea floor, it tows ORB behind it. RUM's advantages are that it can go—and stay many days—where it's difficult or impossible for fragile man to explore in person.

New image-storing technique

A Bell Laboratories scientist projects his company's symbol from a ferpic—a ferroelectric ceramic picture device, made from a material first announced by Sandia Corp. In a ferpic, an image is stored as a variation in the way the ceramic plate transmits polarized light. The image can be stored indefinitely, or electronically erased or changed. Applications will be in low-cost, solid state information displays.

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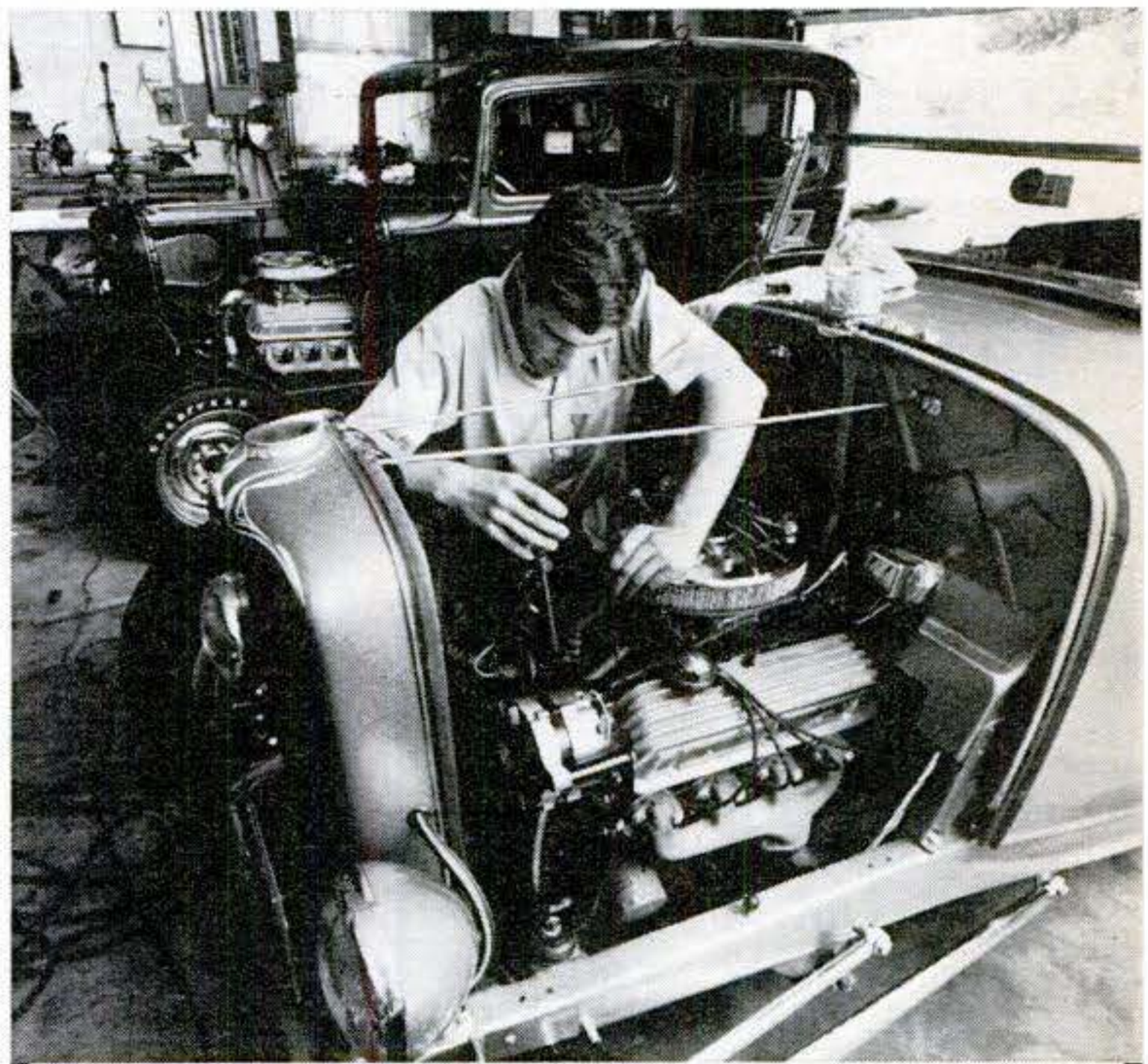

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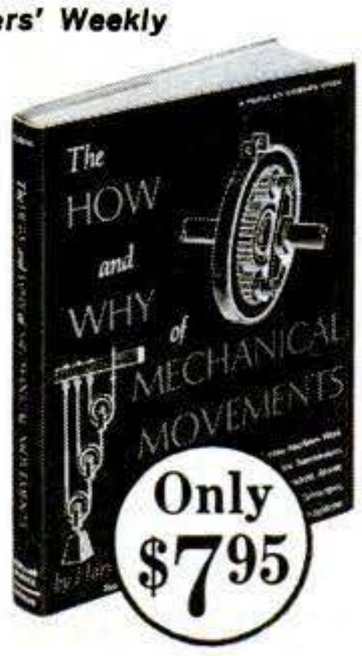

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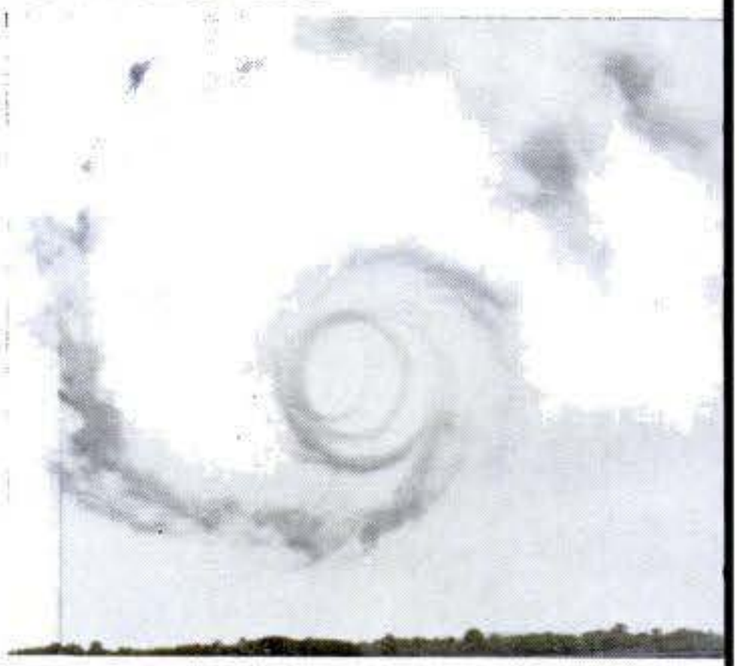
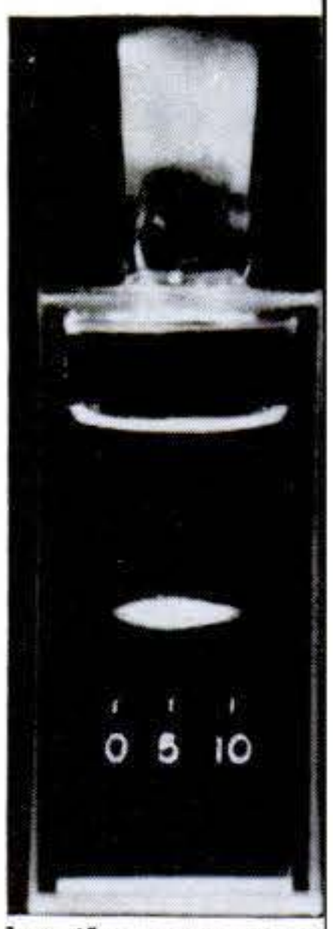
It's a red tornado



What caused the peculiar tornad shaped formation in this picture? A j plane flying through a cloud of colore smoke released by the tower at left. It all part of a NASA investigation of tu bulence in the trailing wake of aircraf Ordinarily, of course, this whirlpool turbulence is invisible to the pilot of plane following behind. This can spe disaster to a small plane in the wake a big jet. The Federal Aviation Agenc will use data from these experiments set safe following distances near ai ports. (Note: The National Transpo tation Safety Board has just warne that wake turbulence can be dangerou to small planes even when they are on runway *parallel* to a landing jet.)

Catching the uncatchable



"Go and catch a falling star . . ." Bell Laboratories scientists have achieved the near-equivalent by taking a stop-action photograph of the world's fastest-moving "object"—a pulse of laser light.

You can see the pulse as a cigar-shaped streak in the stoppered bottle of water shown. It is traveling from right to left and is actually about a fifth of an inch long. (The numbers below represent millimeters; the length of the pulse is exaggerated by the exposure. The light itself is green. It is visibl because it is being scattered by very fin particles of milk suspended in the wate

Secret of this remarkable picture is new shutter, developed by Michel Du guay and John Hansen, which make the exposure in *10 trillionths of a sec ond*—the duration of the pulse. It work by changing the light-polarizing proper ties of a chemical. The changes are trig gered by the laser light itself, makin possible an incredible degree of syn chronization. The new shutter break the old ultra-high-speed record, held b another type of chemical shutter, b about 100 times.

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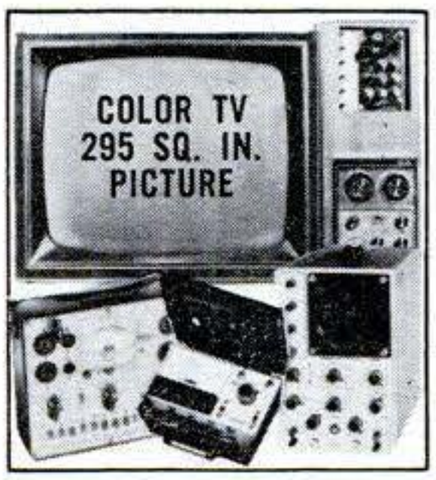

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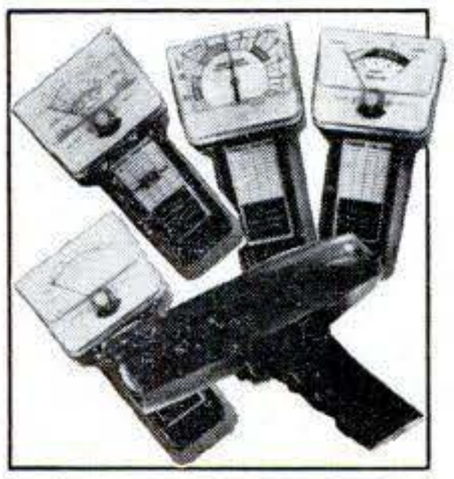

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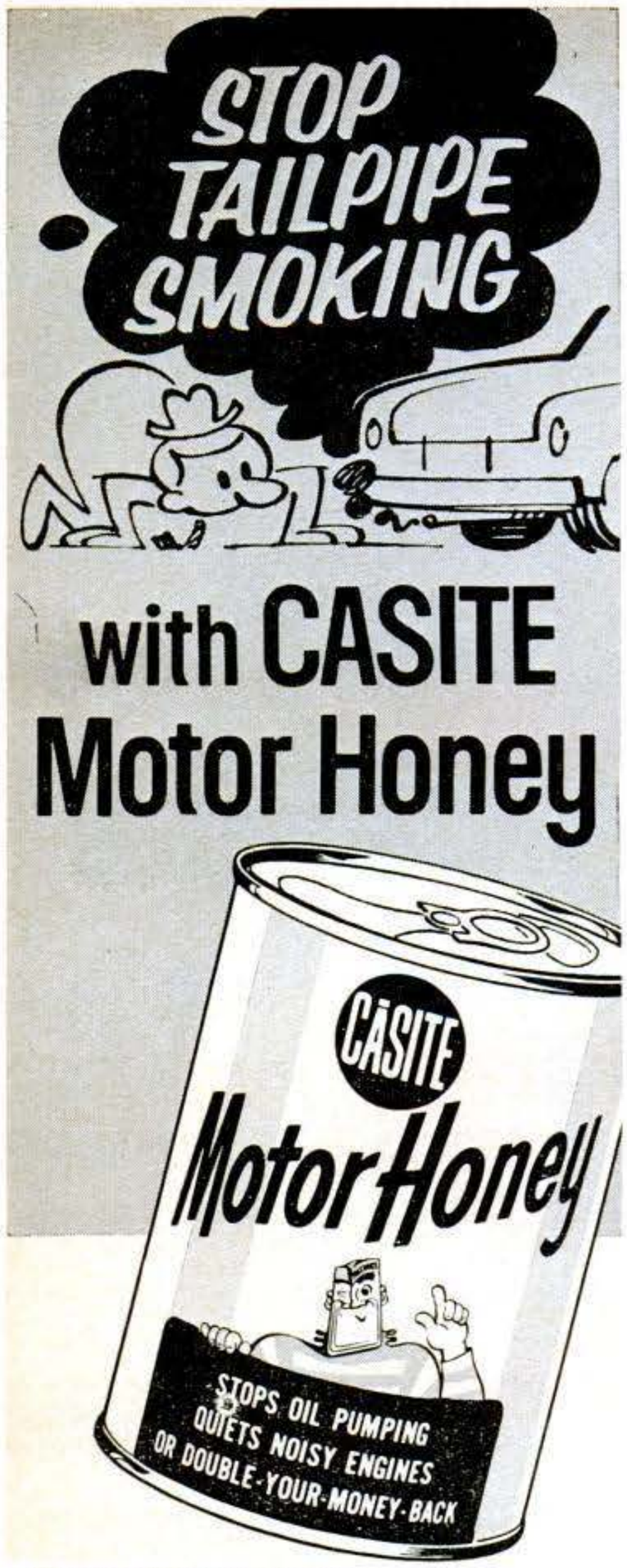

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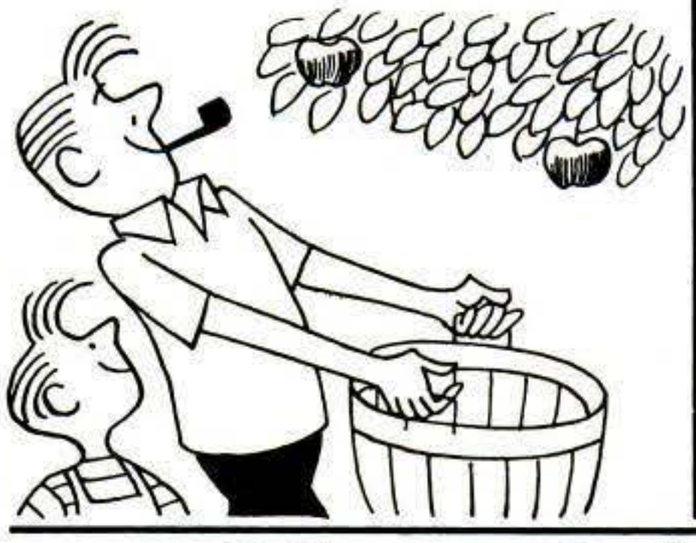
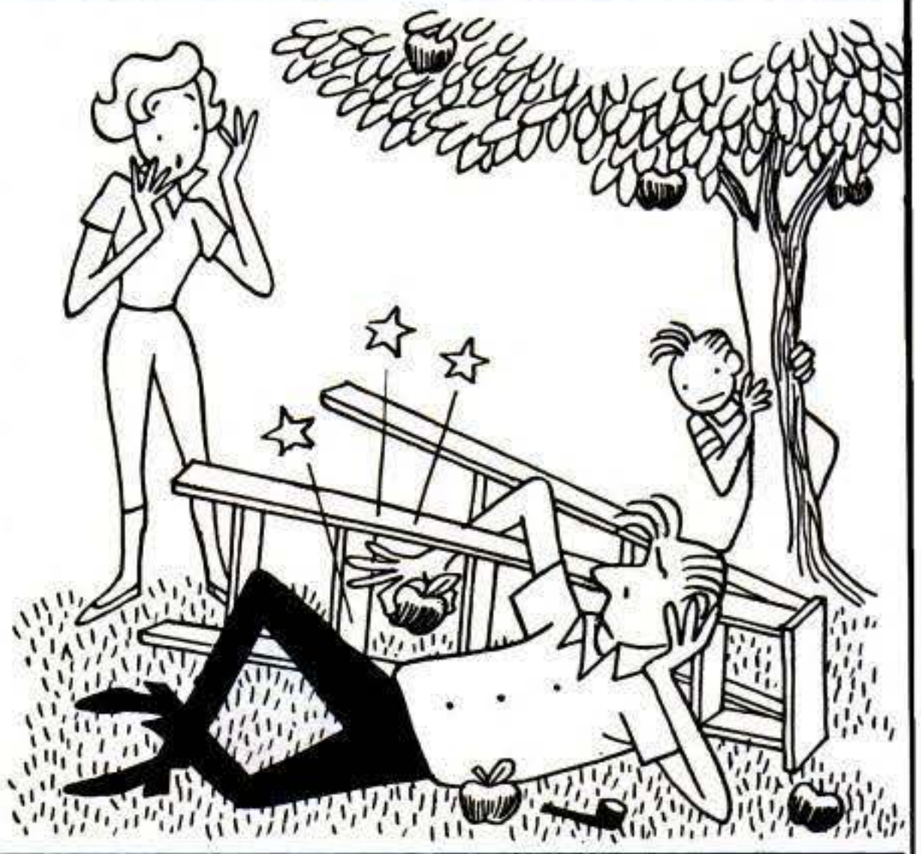
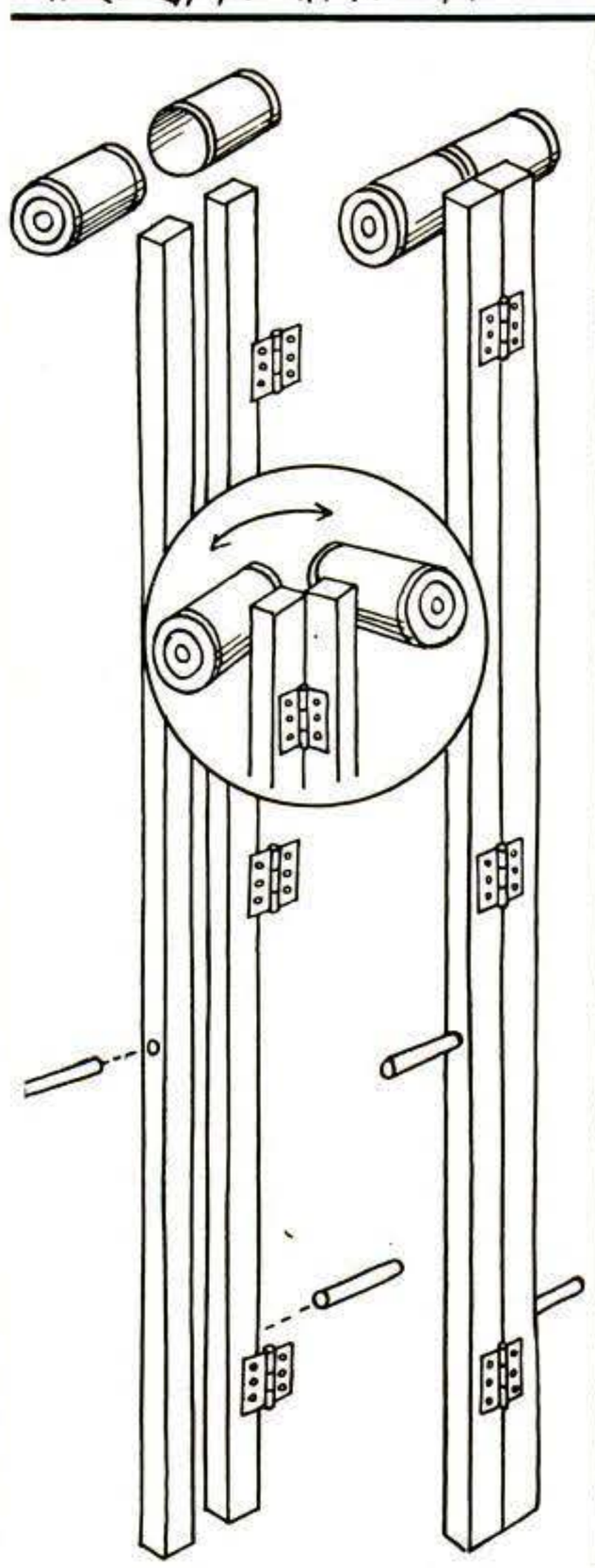
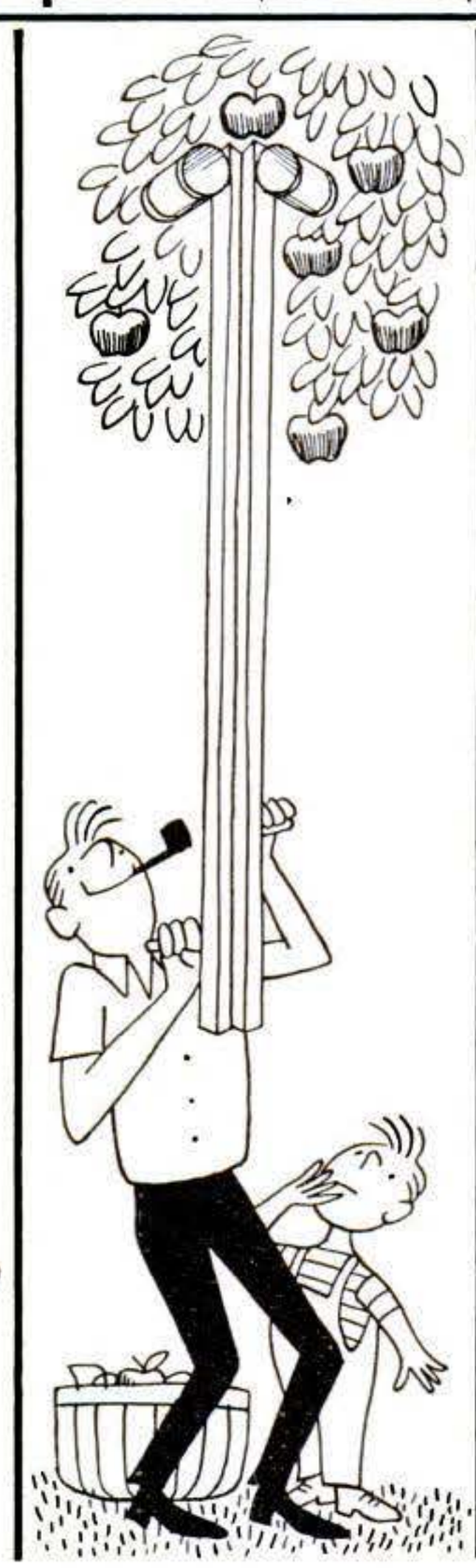
Wordless Workshop

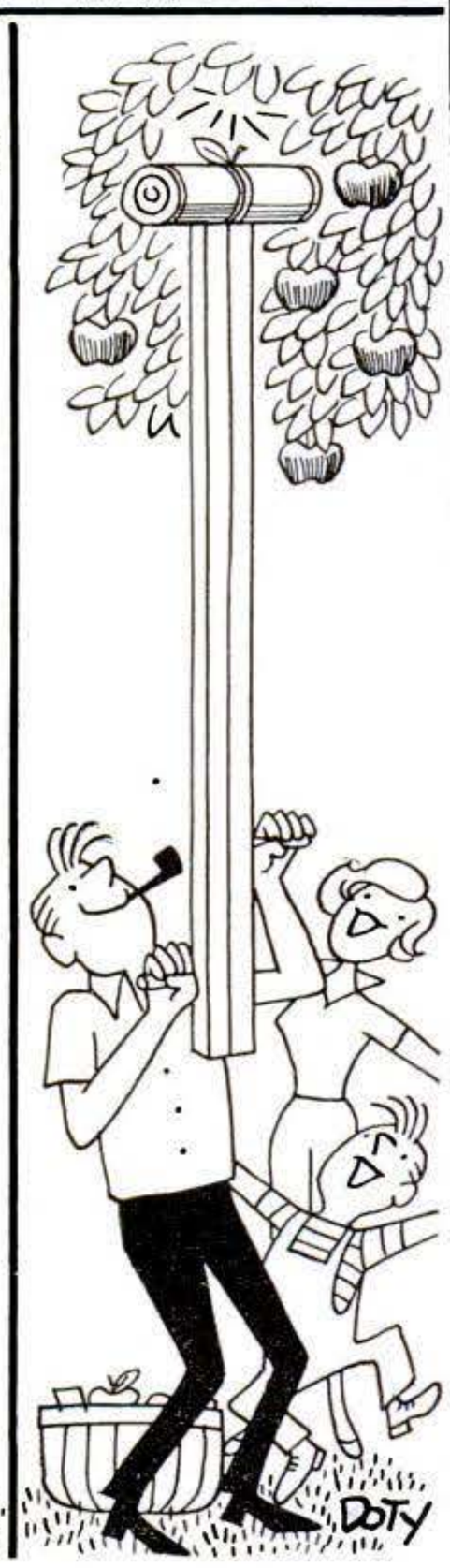
By ROY DOTY











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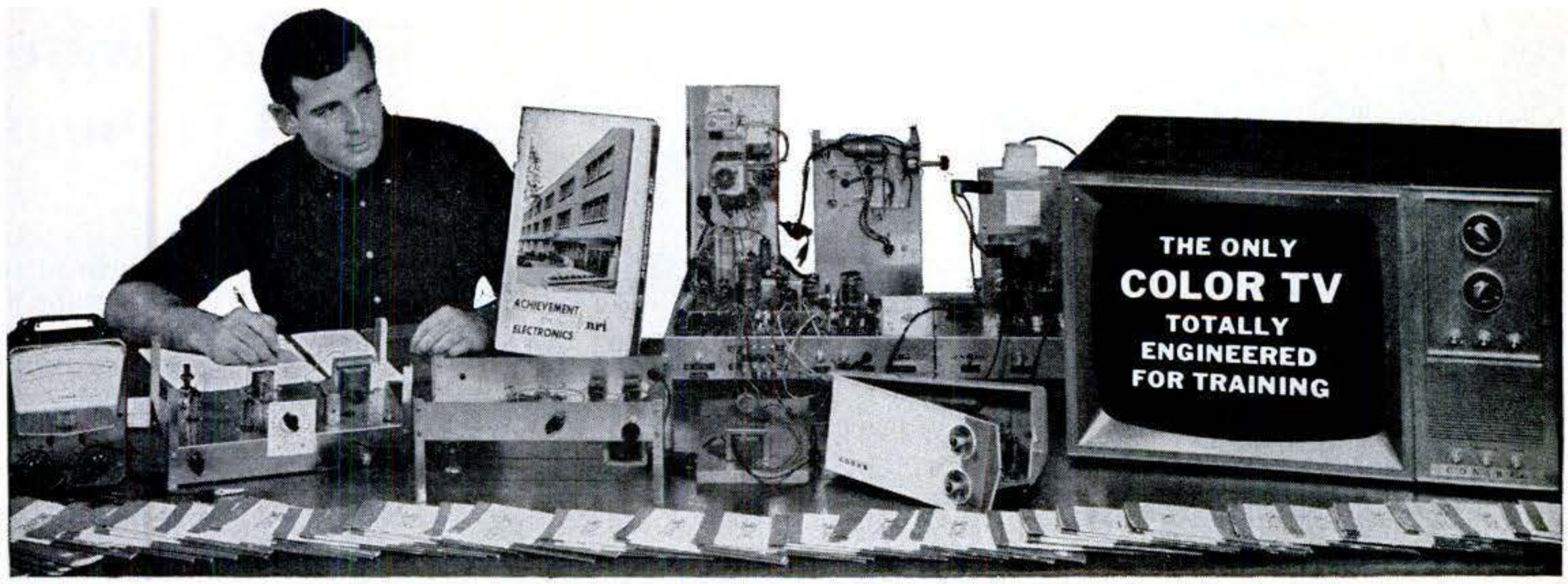

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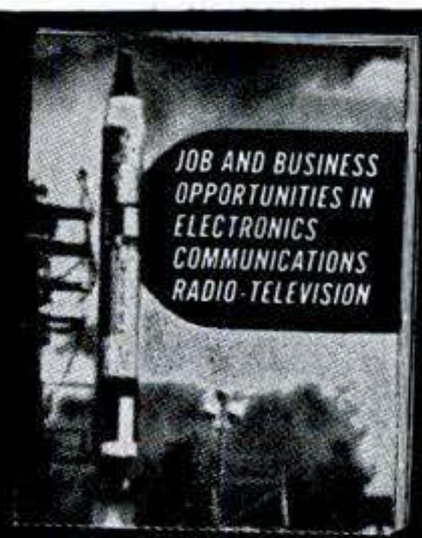

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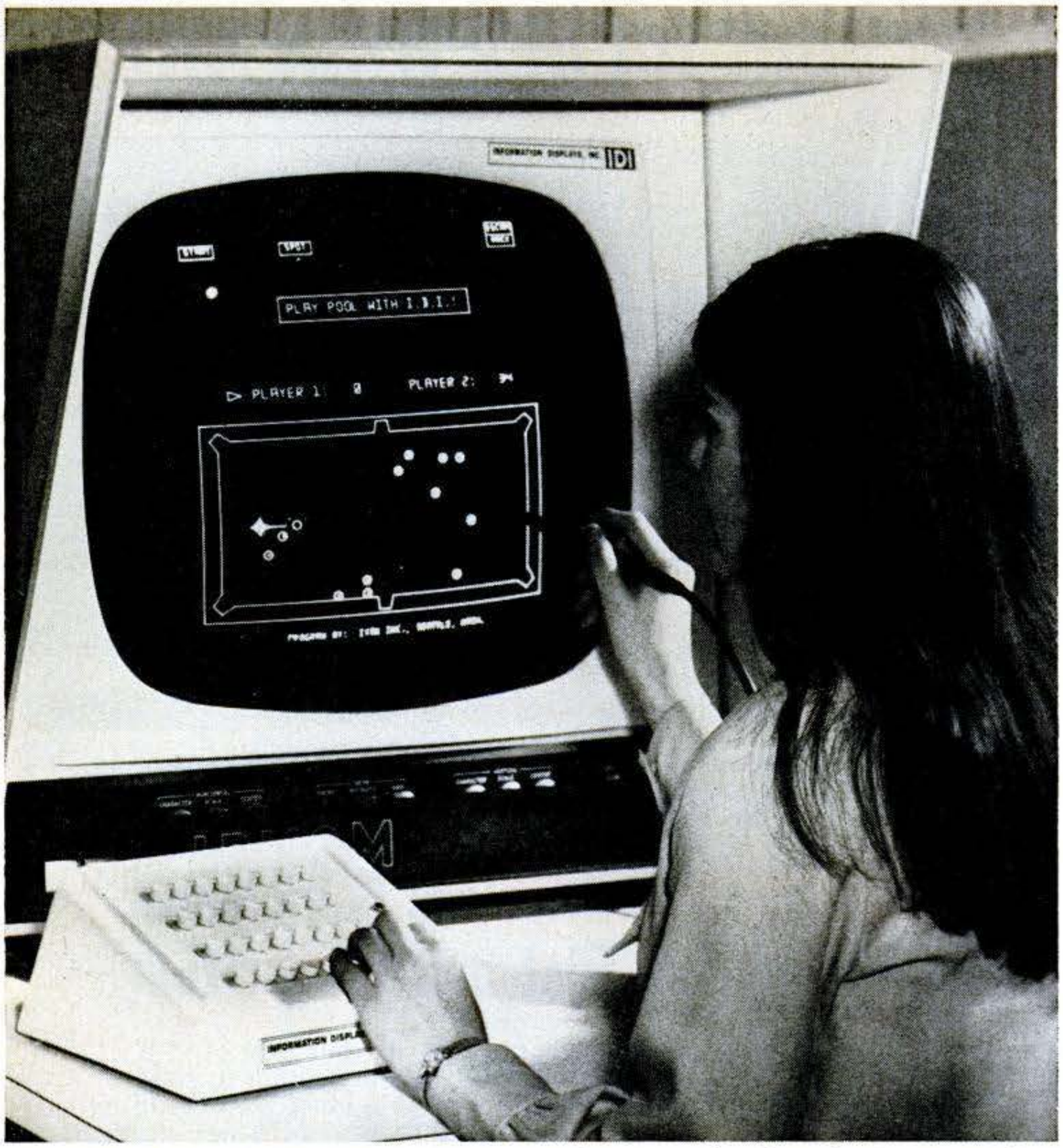


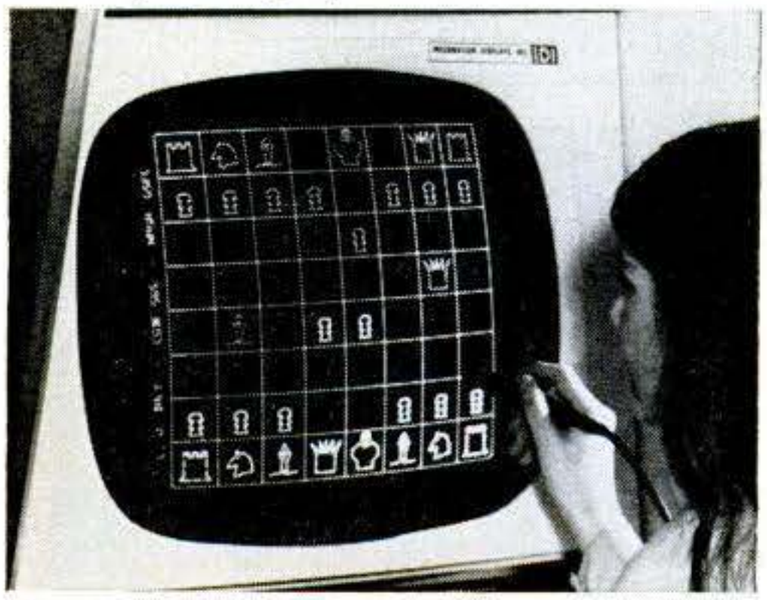
Line up a shot with the electronic cue and shoot—straight shots, banks, or combos.

Games Computers Play

Who needs a billiard table? Now you can shoot pool on a computer's TV screen

I studied the chess set displayed on the computer TV screen. At my command, the black queen's pawn moved two blocks forward. The screen blinked—the computer was thinking—then the white queen's pawn moved.

I was at Information Displays Inc., a computer graphics firm in Mount Kisco, N.Y. Under the guidance of Carl Machover, IDI vice president, I was playing chess with a computer.



For a real challenge, tackle a computer in a game of chess. To play, touch piece, then indicate square you want to move to.

Computer games were introduced some years back. The news is how far they've come since mastering their first, elementary ploys. After I lost that chess game I found out.

Machover flipped a few switches. The chessboard vanished and an image of a pool table, complete with a rack of balls, appeared on the screen.

Using a cable-operated electronic probe as a cue, I aimed and sent the cue ball flying into the pack. Then I settled down for some real fun, working on simple shots and trying to get the feel of the "table." I found I could make cuts, banks, even combinations. The display behaved just like a real pool table. The only difference: I couldn't vary the force of my shots—the "balls" always traveled at a fixed speed.

The games are just for fun, but they demonstrate the adaptability of computer graphics. It's a new field, and in applications such as air-traffic control it could very well save your life some day.—*Sam Shatavsky*

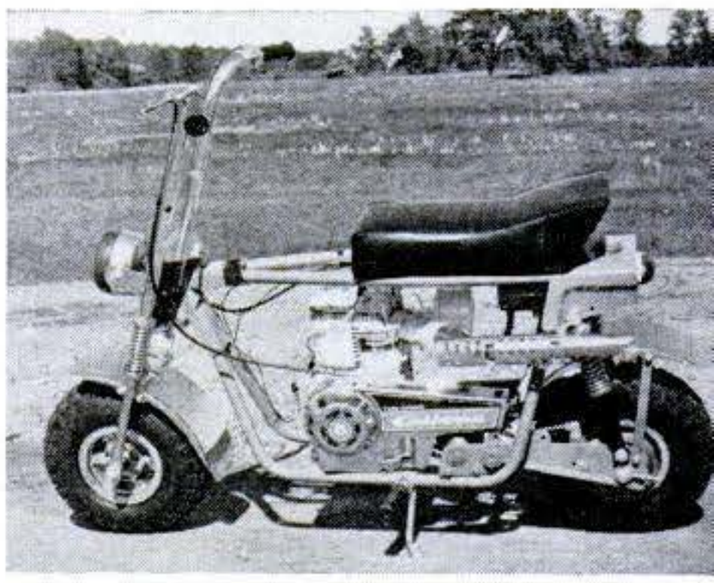
Three New Minibikes with Lots of Options

Now there's a way to ease yours onto the seat of a top-flight minib a step at a time. Buy either the thr or four-hp model in the new line Gilson Holiday bikes. Later you c add options like rear shocks, fende and decorative trim (standard on t top-of-the-line five-hp Holiday 19 If you like, you can even change up the 190's five-hp engine and two-spe drive.

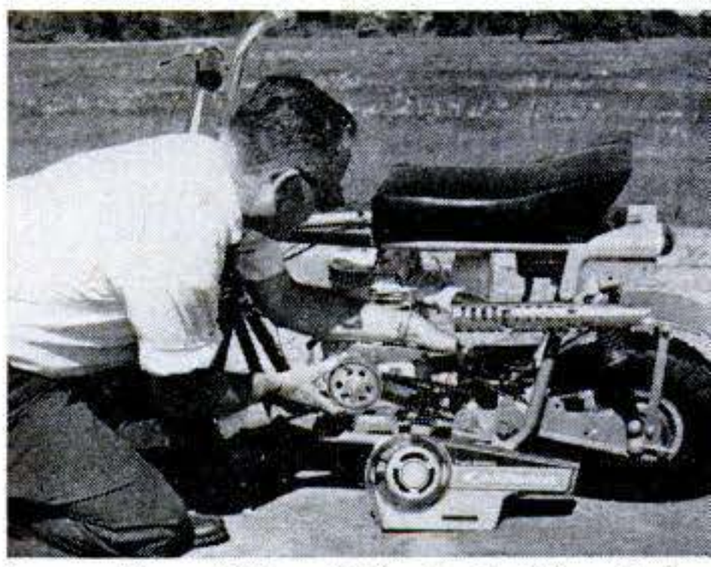
All models have front coil sprin Tecumseh engines, and jacksh drive. All use centrifugal clutch but the 190 has two clutches and t chains. As speed increases, the s ond clutch engages and the gear ra changes automatically.

Gusseted frames instead of co ventional butt welds, safety ignitio kill switch, alternator-powered ligh split wheels for easy tire service, b bearings throughout, and other qua ty features make the new Gilsons i teresting entries in the growi minibike market.

Prices? $179.95 for the three-l model, $209.95 for the four, an $289.95 for the five.—*E. F. Lindsl*



Fancy features—chrome fenders, headlig taillight, and trim—are standard on Holic 190, options you can add to other Gilso



Inspection of the 190's dual drive chains quick and easy. Remove a single clip a guard over clutches, and drive comes o

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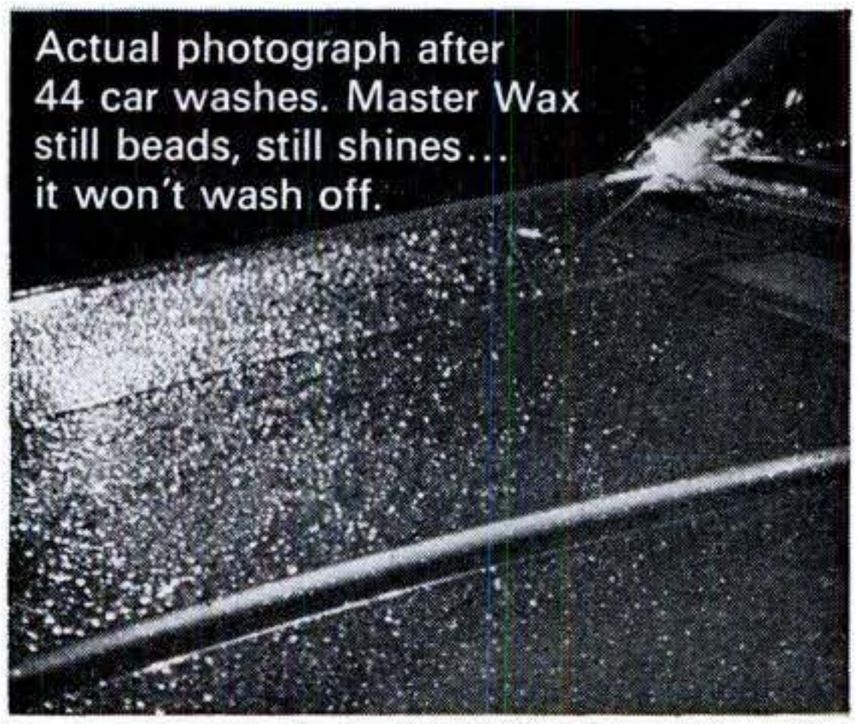

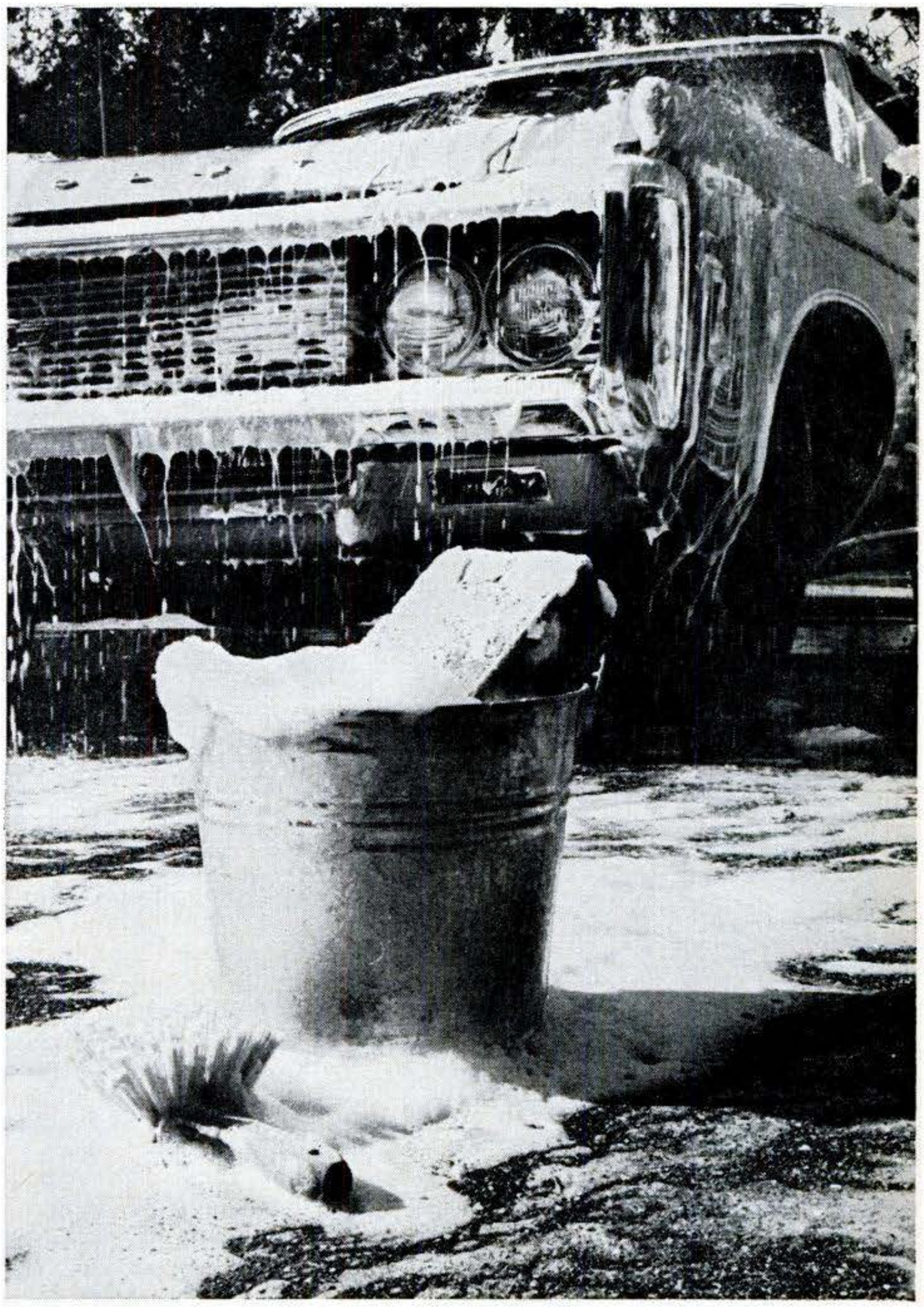

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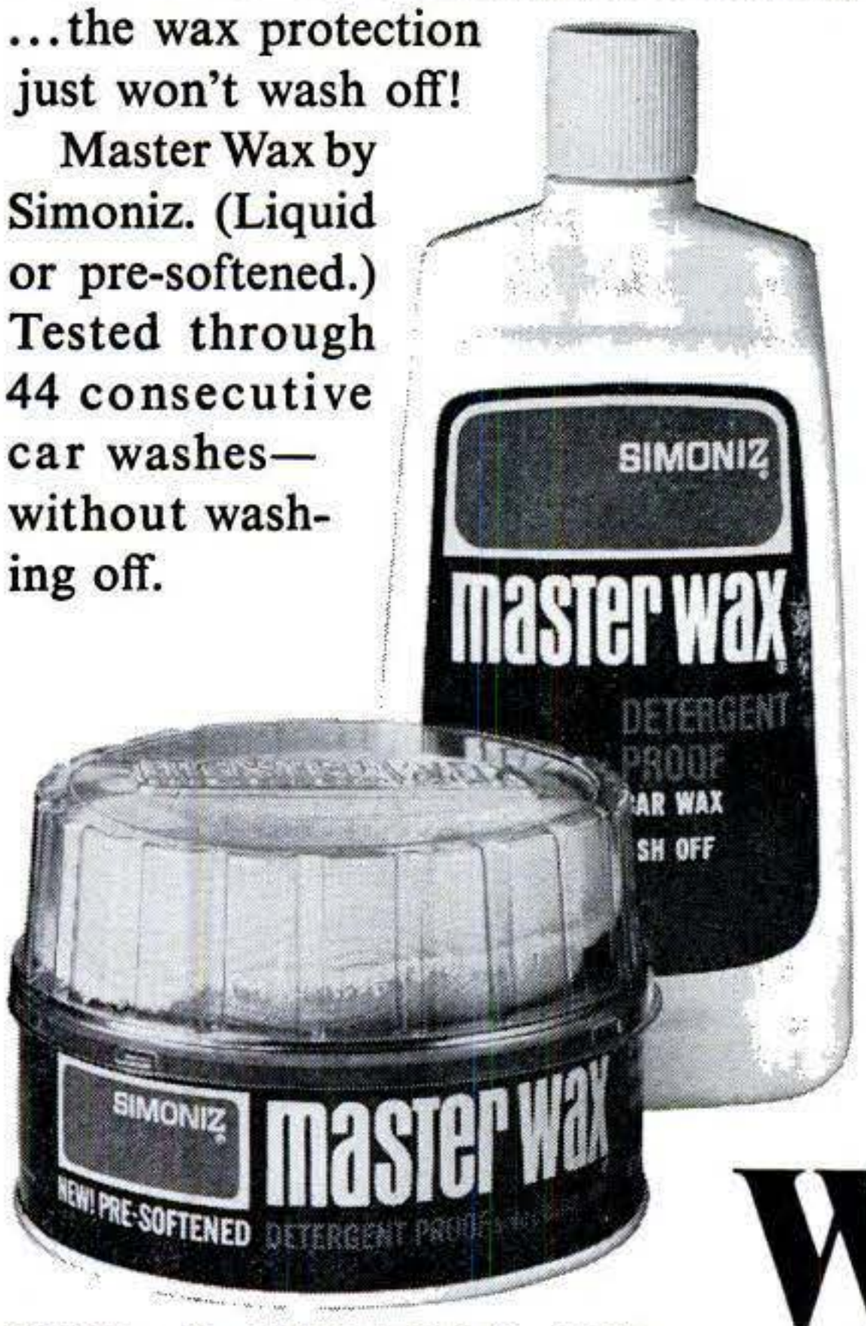

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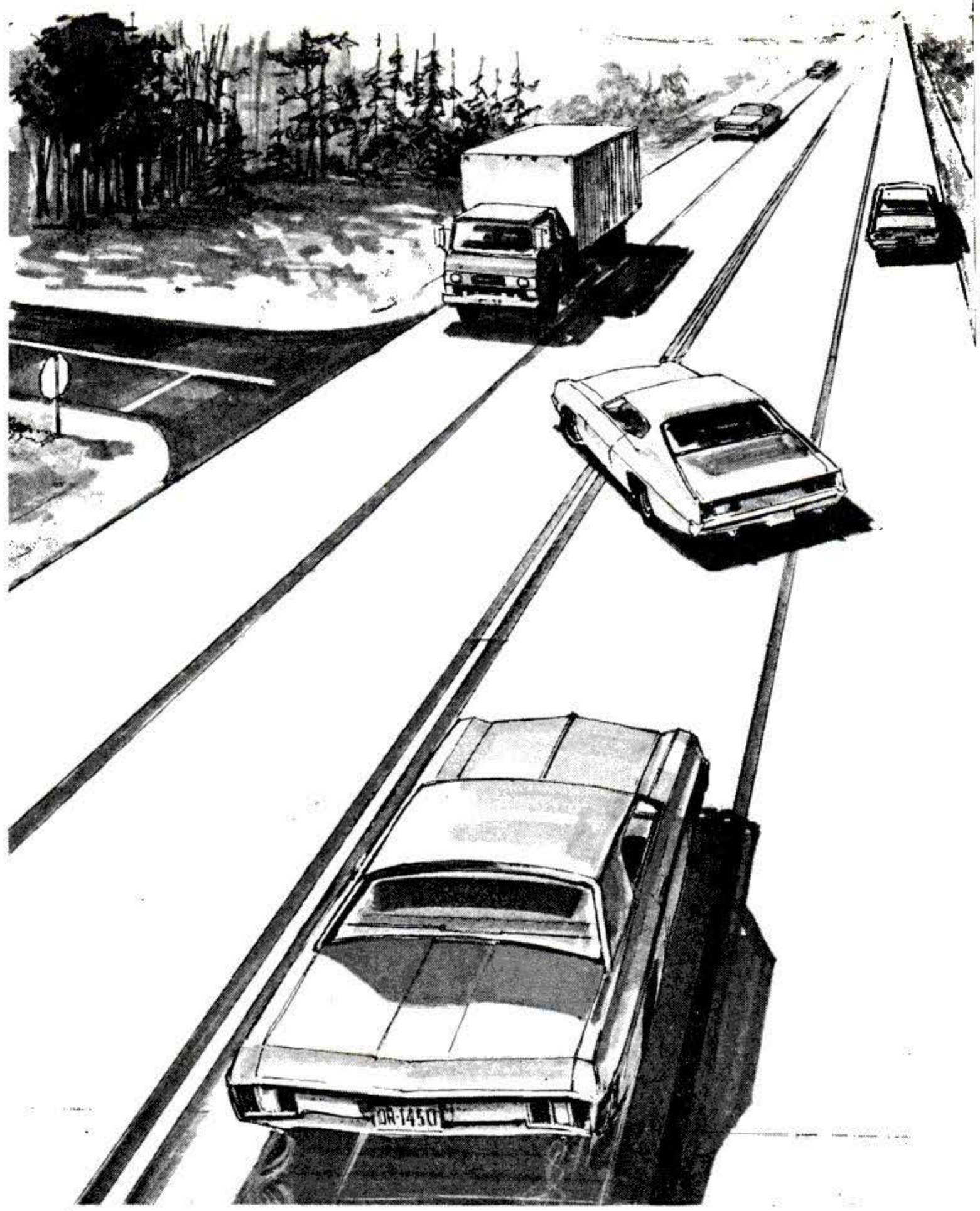

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by Lawrence Galton

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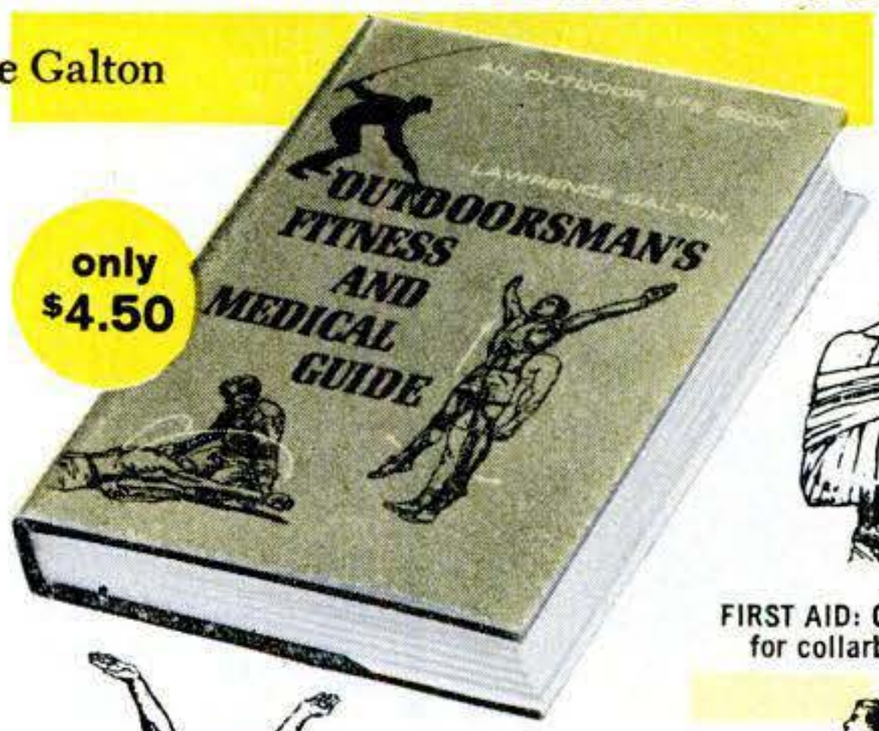

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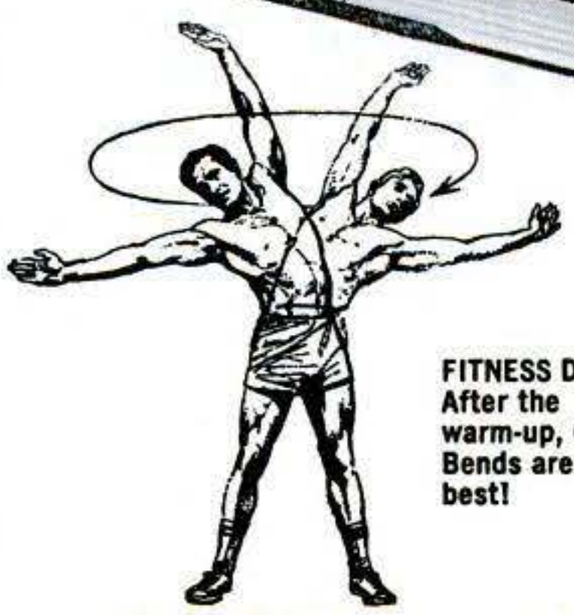

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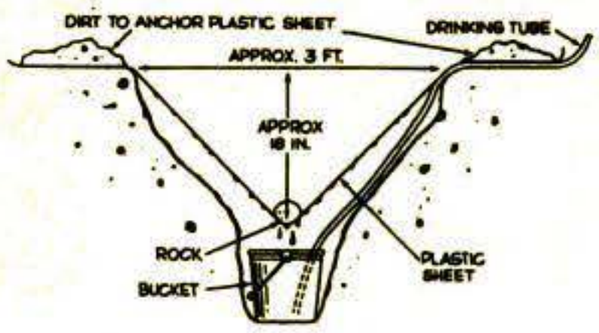

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MONEY BACK GUARANTEE

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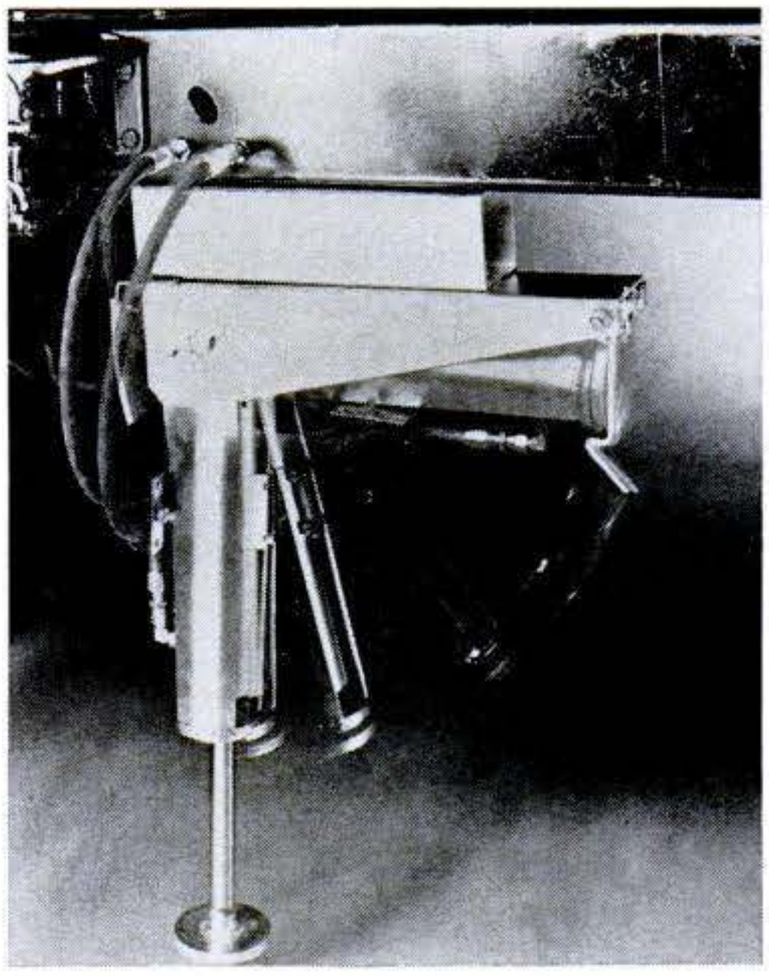
Avco Grand Lodge (above) is built on new International Harvester chassis (right)—the first for motor homes only.

Made for Each Other: Chassis and Motor Home

Interior luxury of Avco motor home is as impressive as the unique frame it's built on.



Automatic leveling system in chassis has a jack like this at each wheel to make it easier to level vehicle in parking spot.

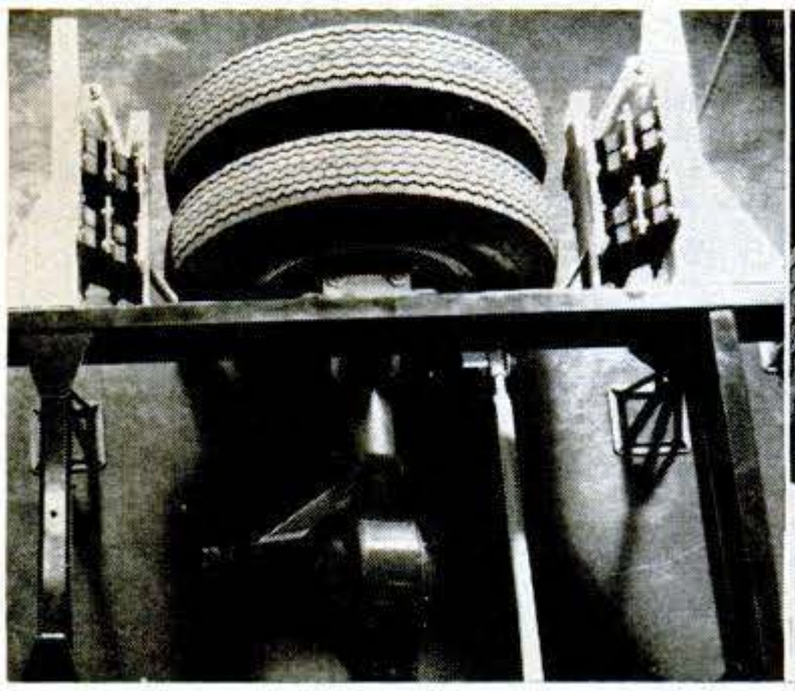
By JIM DAVIS

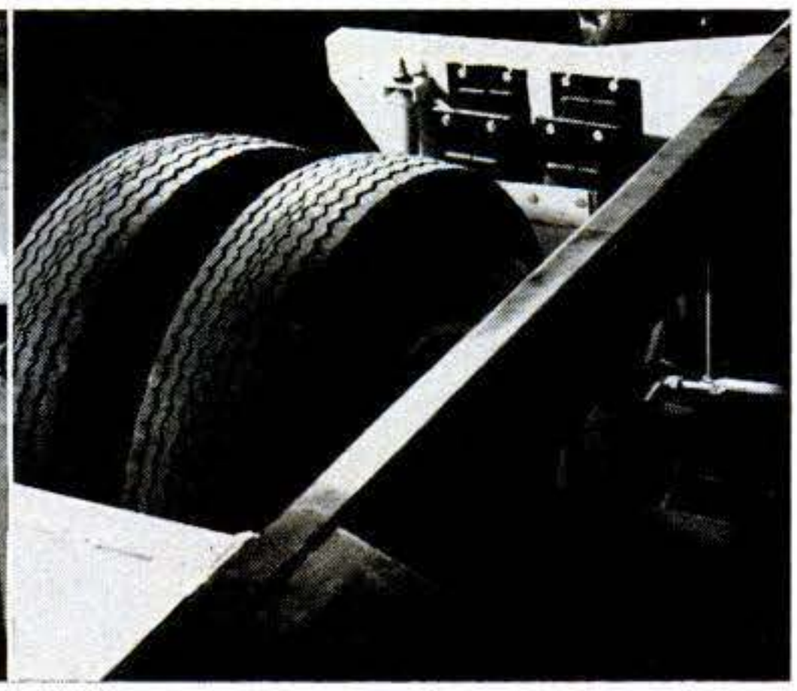
The first chassis ever designed exclusively for a motor home has been introduced by International Harvester—and it's loaded with features that promise a more stable and safer ride.

Look at some of those features: a self-adjusting, hydraulic dual split brake system, with the largest brake-lining area for motor homes; an International V-392 engine, rated at 236 hp net; an automatic leveling system operated through a dashboard control; and an optional rear outboard suspension system.

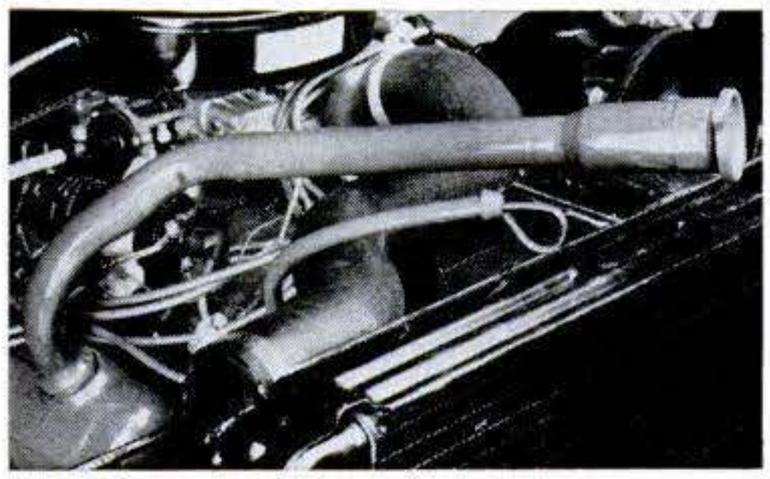
The outboard suspension is the Mor/Ryde system, which consists of two sets of rubber springs bolted onto the frame, about a foot outside from where standard leaf-spring centers would go. It's like putting pontoons on a canoe. It reduces sway and tilt more effectively than the heaviest springs previously used.

First motor home to use the International chassis is the Avco Grand Lodge, and Starcraft will soon introduce the new chassis in its motor homes. The chassis comes in 137-, 159-, and 178-inch wheelbases. PS





Outboard suspension system, optional feature of International chassis, reduces sway and tilt in the rear end. The rubber springs are bolted on the chassis about a foot farther out than leaf springs would be. Estimated life of springs is 15 years.



Extending oil filler and dip stick are nice touches on new chassis, and make proper maintenance easy. They're optional features.

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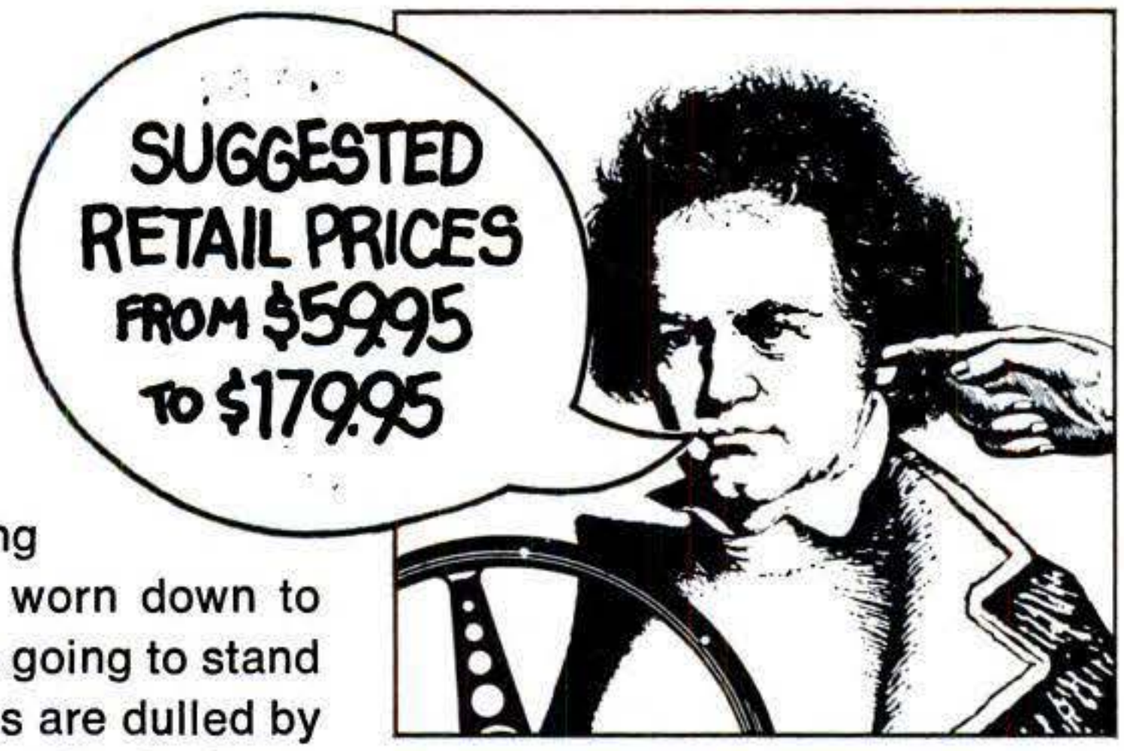
ear pollution solutions



Friends! Motorists! Countrymen! The ears of America have taken such a beating lately that they're worn down to the drums! Are we going to stand by while our senses are dulled by the ugly din of ear pollution? No! We're going to fight the threatening noises on our streets and highways with the ear pollution solution—a Craig Car Stereo Tape Player.

With a Craig in the car, you control what you hear. Listen to tape cartridge albums of your favorite recording artists whenever you want to. Just roll up the windows and your car becomes a beautiful stereo sound chamber.

Act now! Visit your Craig dealer's Ear Pollution Control Center and see the many different Craig Car Stereo Tape Players on display. Your Craig dealer knows he must make sacrifices, too, if we're going to end ear pollution, so he's featuring special prices on all models beginning at just $59.95, suggested retail for the 8-track model 3126. You'll find a Craig for every car including models with AM and FM Stereo radios. Choose your weapon now while the price is right and make music, not noise. Remember Craig.

The Ear Pollution solution!

MODEL 3123

MODEL 3121

MODEL 3108

MODEL 3126

CRAIG CAR STEREO

PS-1

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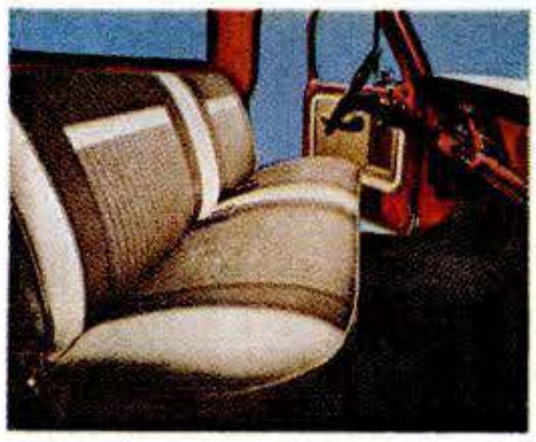
New'71 Ford pickup works like a truck, rides like a car.

Twin-I-Beam suspension is one of the reasons. Consider these others:

Biggest cab of any pickup.
Combined headroom, legroom, shoulder room and seat height dimensions exceed those of any other pickup cab.

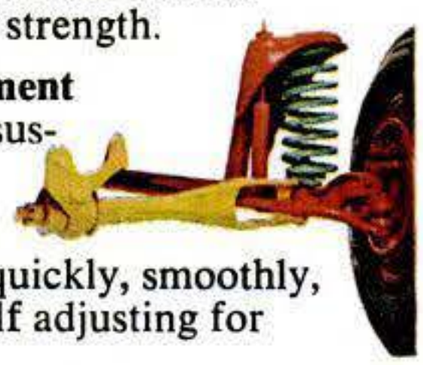
Only Ford has Twin-I-Beam independent front suspension.
Wheels step over bumps independently to smooth the ride.

Levelest, quietest ride of them all.
Virtually no nosedive on braking, less sidesway on curves. Independent tests proved Ford is quieter than all other leading pickup makes.



Most luxurious.
Choose from four levels of luxury . . . all the way up to the unique Ford Ranger XLT, most luxurious pickup ever built. Distinctive good taste marks the XLT: wood-tone accents, thick-pile carpeting, deep-cushioned seats upholstered in pleated cloth and vinyl, plus luxury options like AM/FM stereo and air conditioning.

I-beam front axles.
A Ford exclusive. Both axles are drop-forged I-beam design. Everybody's *big* trucks use I-beam front axle design for greater strength.



Radius rods help hold alignment better than any other front suspension system. Only Ford pickups offer radius rods.

Self-energizing brakes stop quickly, smoothly, with little pedal pressure. Self adjusting for lower service costs.

Welded, instead of bolted, pickup box stays strong, resists working loose, means greater quietness, less chance of rust.

Leaf-type rear springs, like all big trucks use, for better stability. Exclusive Flex-O-Matic rear suspension, standard on F-250 and with heavy-duty springs on F-100, keeps the ride smooth, with or without a load.

Make sure your next pickup includes the better ideas you get only from Ford. See your Ford Dealer for the pickup that works like a truck, rides like a car.

FORD PICKUPS

Ford

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New: Minto's Unique Steamless "Steam" Car

This antipollution car uses an external-combustion engine with a refrigerant for a working fluid. Soon it will go into production—in Japan

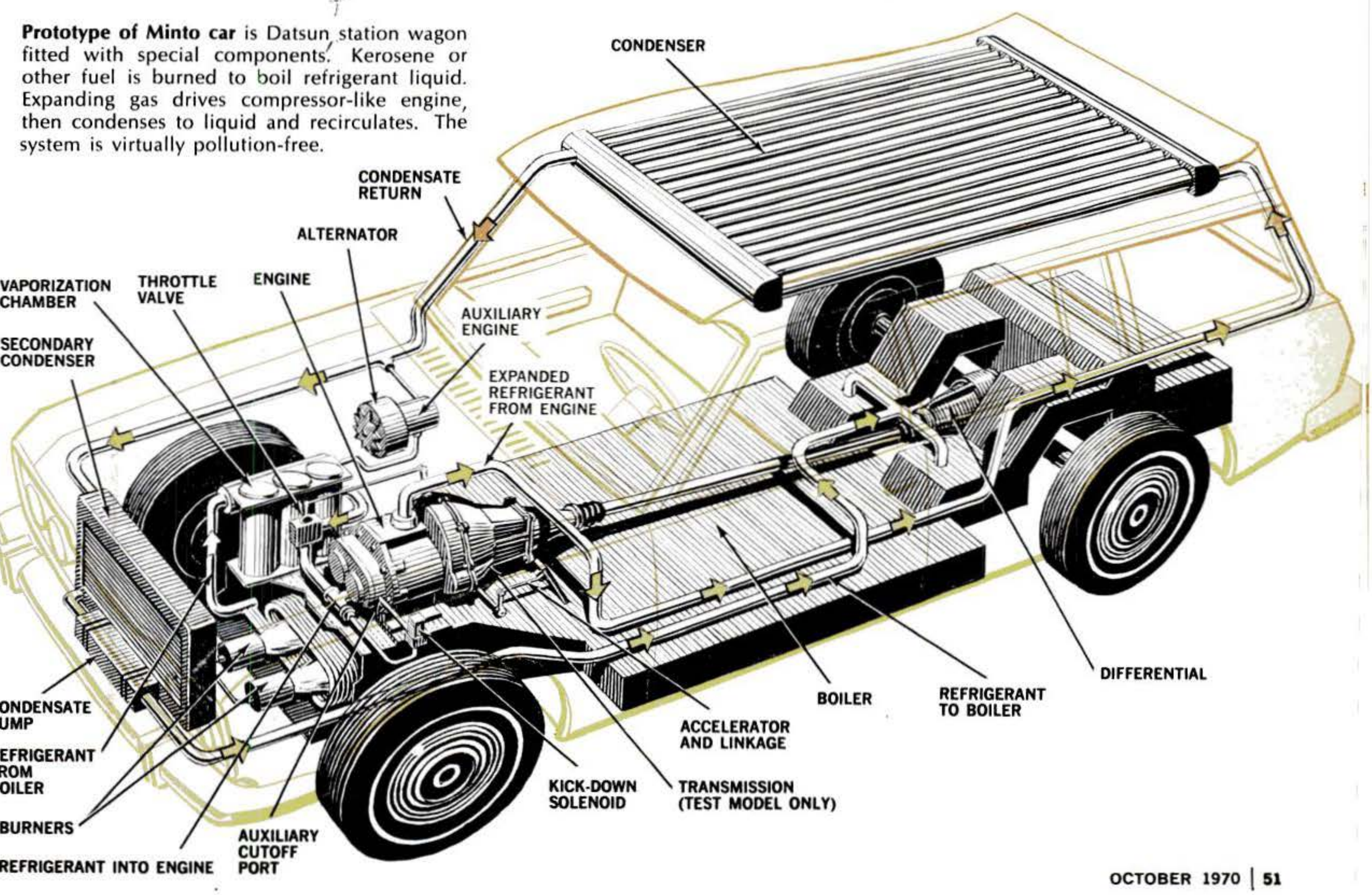
By E. F. LINDSLEY
ILLUSTRATION BY RAY PIOCH

Just about now, if you happen to be a reader living in the Southeast, you may see a Datsun station wagon pull up to a stoplight: It will probably catch your attention because you won't hear the engine idling as the driver waits for the light. You'll also notice that the little wagon moves out briskly and almost silently—the only sound will be a soft whine. And you won't see any exhaust. You will be looking at the prototype of one of the first really pollution-free cars ever built —one that Datsun's maker has agreed to produce by 1972!

Under the hood will be a small, and unique, engine driven by expanding fluorocarbon. The heat to expand the R-113 fluorocarbon refrigerant will come from burning hydrocarbon fuel, probably kerosene (although almost anything will do). According to Wallace L. Minto, developer and President of Kinetics, Inc. in Sarasota, Fla., the secret is no secret—external combustion, properly engineered, of course, produces only carbon dioxide and water. Both are normal components in our atmosphere. The Datsun will emit no semiscavenged lead, no measurable oxides of nitrogen, and virtually no carbon monoxide.

Steam-engine fans, aware of the merits of external combustion and the simplified mechanics and drive train made possible by expanding a nonburning gas, have long

Prototype of Minto car is Datsun station wagon fitted with special components. Kerosene or other fuel is burned to boil refrigerant liquid. Expanding gas drives compressor-like engine, then condenses to liquid and recirculates. The system is virtually pollution-free.



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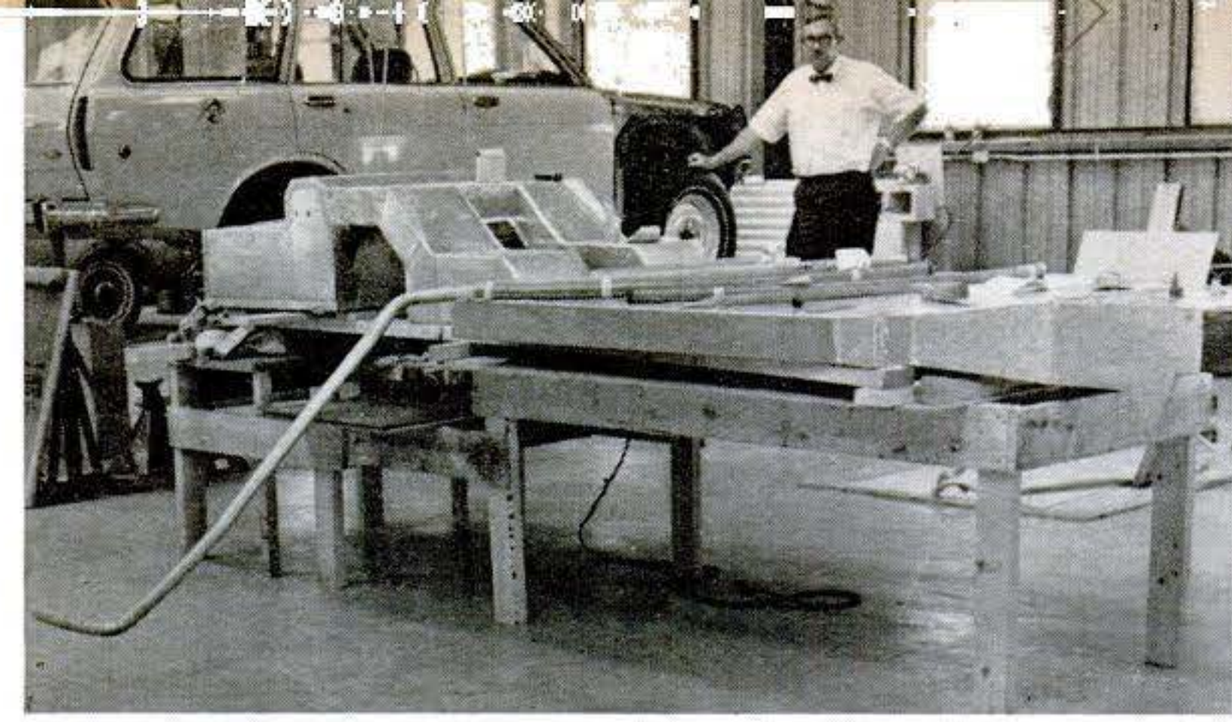

Datsun station wagon being fitted with refrigerant engine will receive the boiler housing seen in foreground. Housing looks oversize; actually, it fits precisely under the wagon.

Refrigerant boiler, made of coiled steel tubing, was set up as shown for testing. One like it will slip inside aluminum housing under the car. The burners fire into the front opening.

foreseen just such a car. But practical problems in applying steam have stalled, so far, even the biggest names. Some of the problems with steam are:

- Freezing in cold climates
- High pressures and superheat needed for efficiency
- Bulky size of boilers and piping
- Hazard from hot water and steam in an accident
- Large water volume, wasteful of heat energy on cool-down.

Wallace Minto thinks he has the answer in Ucon R-113 fluorocarbon, Union Carbide's name for a common, noncombustible refrigerant. (Du Pont's name for it is Freon.) R-113 vaporizes at 117 degrees F, a fact of overwhelming importance to safety. Moreover, R-113 has the thermodynamic characteristics needed; it doesn't freeze; it liquefies readily within a condenser of practical physical size; and, because of its high density, it can be handled in small pipes and valves. All of these qualities make for lighter, stronger, and less-expensive parts, which can be fitted into an automobile economically and practically.

A thorough engineer. "The numbers have to check out" is one of Minto's favorite expressions when he talks of the complex laws of gas expansion, entropy, and the work available from an engine. To prove his "numbers," Minto first built a test model using the unlikely combination of a VW minibus and a genuine Stanley Steamer engine. Burning propane as a convenient heat source, he cooked his batch of R-113 in a tubular boiler, fed it through the old Stanley engine very successfully, and condensed it in some cobbled-up cooling coils from conventional refrigeration equipment. This was the classic Rankine cycle, using the working fluid—in this case R-113 instead of steam—over and over. Unlike the dramatic bursts of exhaust steam from old-time locomotives, the Rankine cycle chills the engine exhaust back into liquid, collects the liquid, and re-injects it into the boiler for use again.

Inventor Wallace L. Minto points out rooftop condenser for ancient Stanley Steamer engine, driven by refrigerant fluid, that powers this VW minibus. Vehicle was a test bed to prove theory.

Unfortunately, the Stanley engine was a reciprocating-piston type, and efficiency was not very high. What was needed was a rotary engine with parts that kept turning without changing direction every 180 degrees. A turbine could be used, but turbines lack low-speed torque, work better when wound up tight at constant speed, and take some pretty hefty gear reductions to get down to the working range for a car axle. Minto sought a positive displacement power plant, one that started with high torque from a dead stall—as did the old piston steam engines—and that would eliminate clutches, gear shifts, torque converters, and the other heavy, expensive accouterments of ordinary drive trains.

Vane-type engines, various exotic rotaries, and a host of others were checked out before coming up with two rotors, fluted somewhat like sections of a twist drill with the flutes intermeshing. Initially, the physical diameters and the pitch diameters of both rotors were the same. It worked, but not as efficiently as Minto thought it could.

Compressor in reverse. Eventually, he found what he was looking for in existing air compressors. Here were two fluted rotors, but the flutes were different. Although the physical diameters were the same, the pitch diameters differed. One rotor had six flutes, the other had four. They ran together, but the four-lobed male rotor turned 1½ times the speed of the six-fluted female. The device compressed air efficiently and simply, with only two moving parts.

Minto's engine reverses the air compressor. Fluorocarbon R-113 gas, laced with a fluorosilicone lubricant, enters the space between the rotors, is trapped as the flutes turn and cut off the inlet ports, and expands with a wedging action between the flutes to rotate the engine. The expansion ratio is about 8:1. Starting from zero rotation, as with the car at a stop sign, simple expansion against the positive-displacement rotors starts the car rolling. At higher speeds, the velocity of the gas impinging on the rotors adds significantly to the power.

Mount engines anywhere. The engines, actually Swedish-built Sullair compressors (or, optionally, Japanese Myakawas of almost identical design) are powerful. Size for size, or weight for weight, they are much more powerful than electric motors. The present engines are not especially designed for weight saving, yet they are light compared with equivalent piston engines. Now weighing 55 pounds in cast iron, they will be made of aluminum. They can be mounted almost anywhere in the vehicle and run in any position; straight up, down, or sideways. Minto envisions final application with the engine mounted directly on the rear axle.

Since rotor speed may range from zero rpm up to 8,000-10,000 rpm, or even higher, the present axle ratios in the experimental Datsun are not adequate. For test purposes

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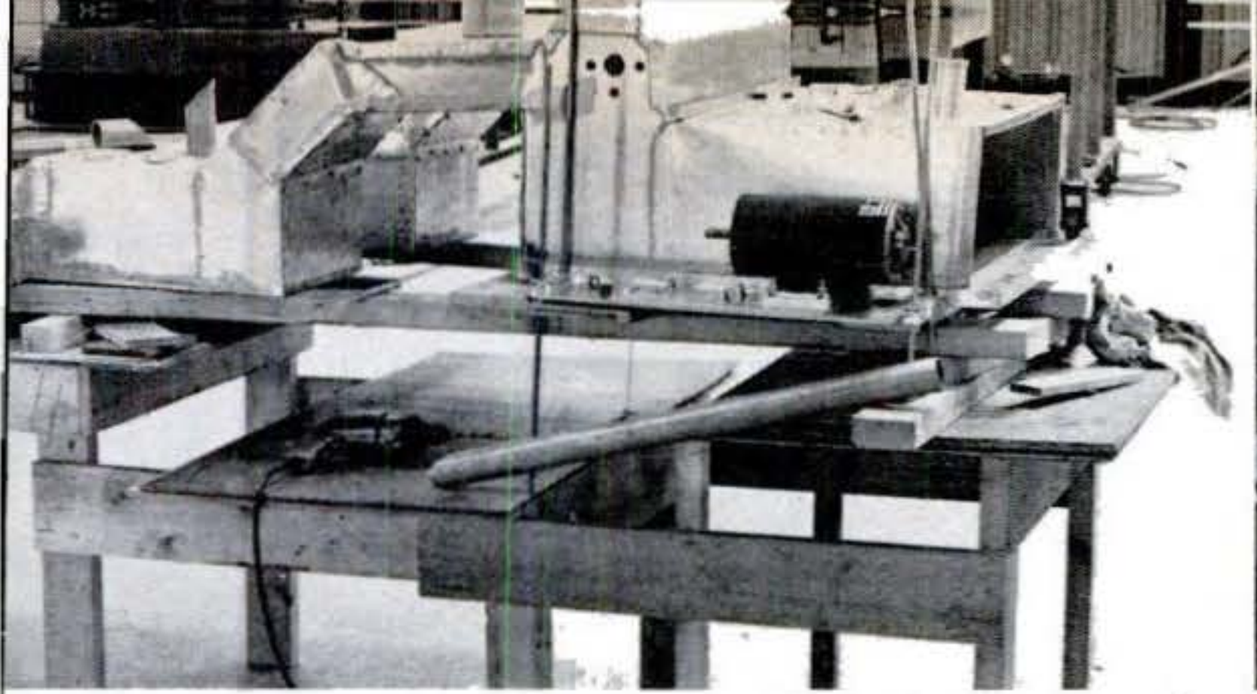
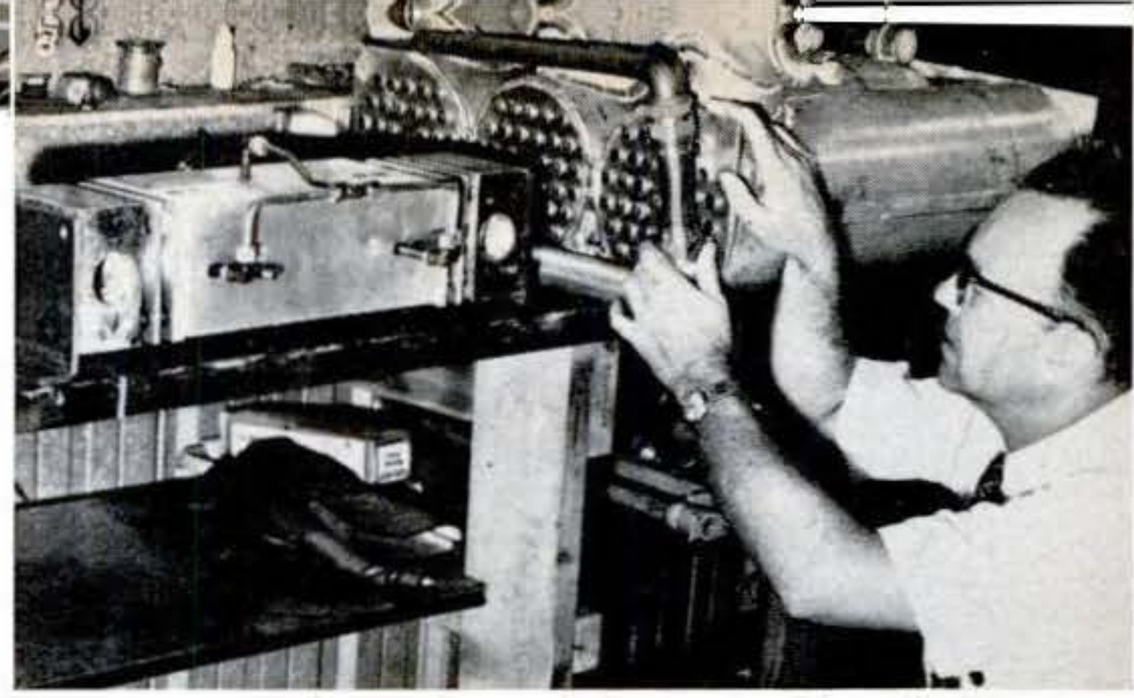


Boiler circulating pump seen at left rear of boiler housing keeps refrigerant liquid moving in boiler to prevent hot spots. Dynamometer and boiler test equipment are set up in background.



Heat recovery and vaporizer unit is examined by Chief Engineer Leonard Keller. Refrigerant flashes into gas and is reheated by burner exhaust here. Box on left is the boiler feed pump.

he uses a conventional gear box behind the engine. Future engines will be direct reversing, but right now he uses the gears to back up and help test engine speed vs. car speeds.

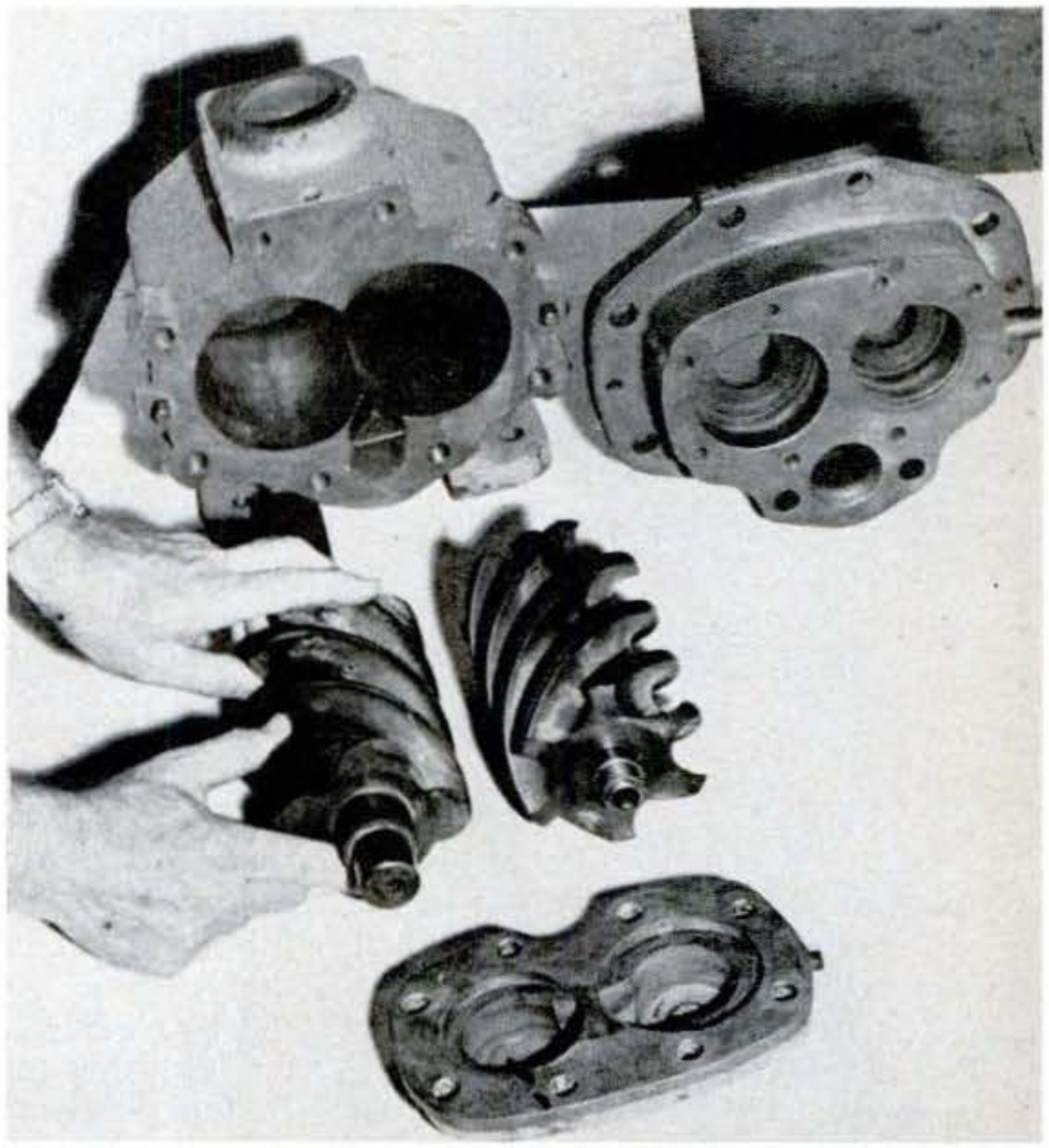
The hardware needed to run Minto's Datsun is necessarily "prototype." After all, adapting an external combustion engine to a vehicle designed for internal combustion can be expected to offer problems of size and shape. Later, a car designed around the fluorocarbon engine will make things easier. So will production components that really fit, rather than hand-fabricated assemblies. Even so, Minto has the following basic parts in workable form:

- Boiler, consisting of a shallow pancake of steel tubing coiled to fit in an insulated, double-walled, aluminum housing snugged up under the car.
- Burners (two) of conventional industrial oil-burner pattern, but highly modified for extremely clean, efficient burning.
- Engine—70 hp at 5,000 rpm, mounted conventionally. High horsepower is not needed because of the excellent torque characteristics.
- Condensers, consisting of a primary, flat, thin, multitube panel mounted in the car roof, and a secondary unit mounted in the usual radiator location.
- Vaporization chamber and heat recovery economizer, to flash the heated liquid to gas and recover part of the burner exhaust heat.
- Throttle, small auxiliary engine to drive alternator, boiler feed pump, fuel tank, and fuel pump.

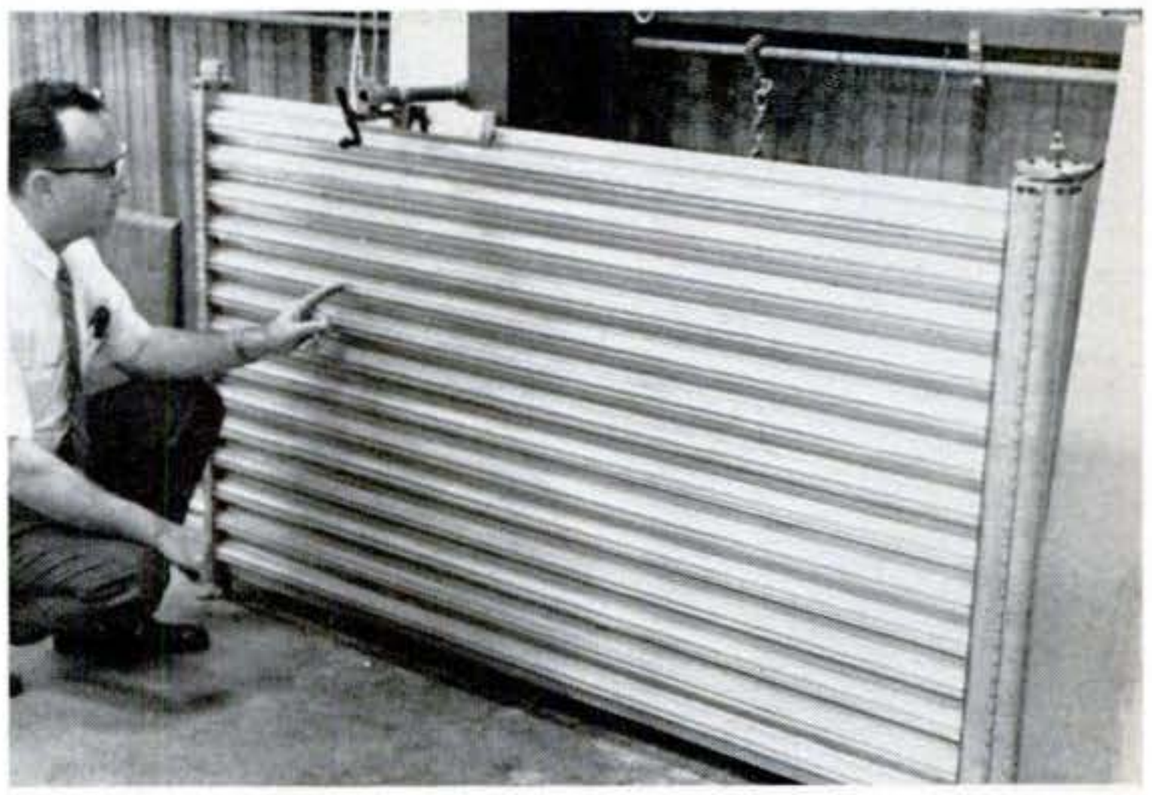
Following the working cycle of the engine from the point where the liquid R-113 is cold in the boiler, here is what you'd see:

How the power flows. After burner ignition by the usual spark arc, the R-113 warms to a working level in about ten seconds. A circulating pump keeps the fluid

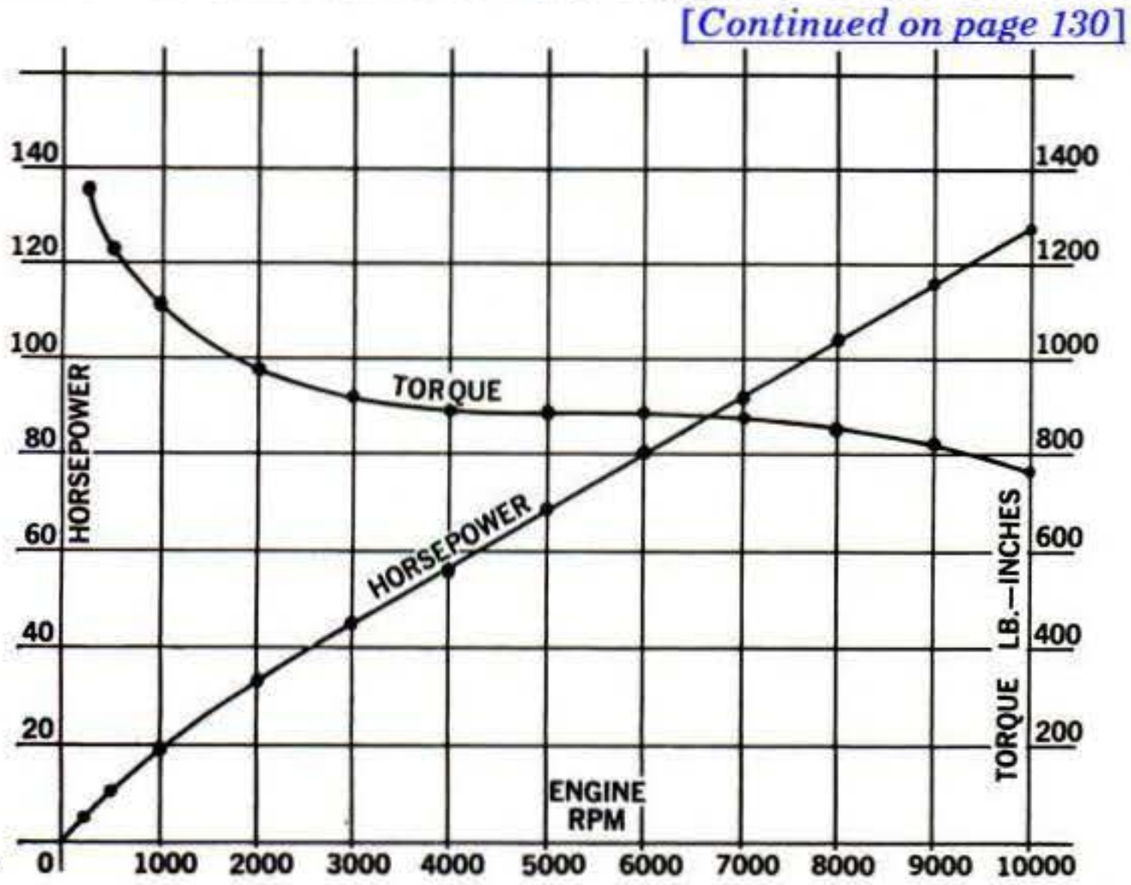
[Continued on page 130]



Gases enter engine through valve plate at front and wedge the rotors to develop high-speed rotation. Male rotor (piston) on left delivers 80 percent of power, turns 1½ times faster.



Rooftop condenser is one of several Minto car components production would improve in shape and other ways. Hand-built test unit shown here is made of aluminum tubing finned inside and out.



Power curves show maximum-load pickup ability when engine starts from dead stall, tremendous torque backup as load pulls engine down to stall.

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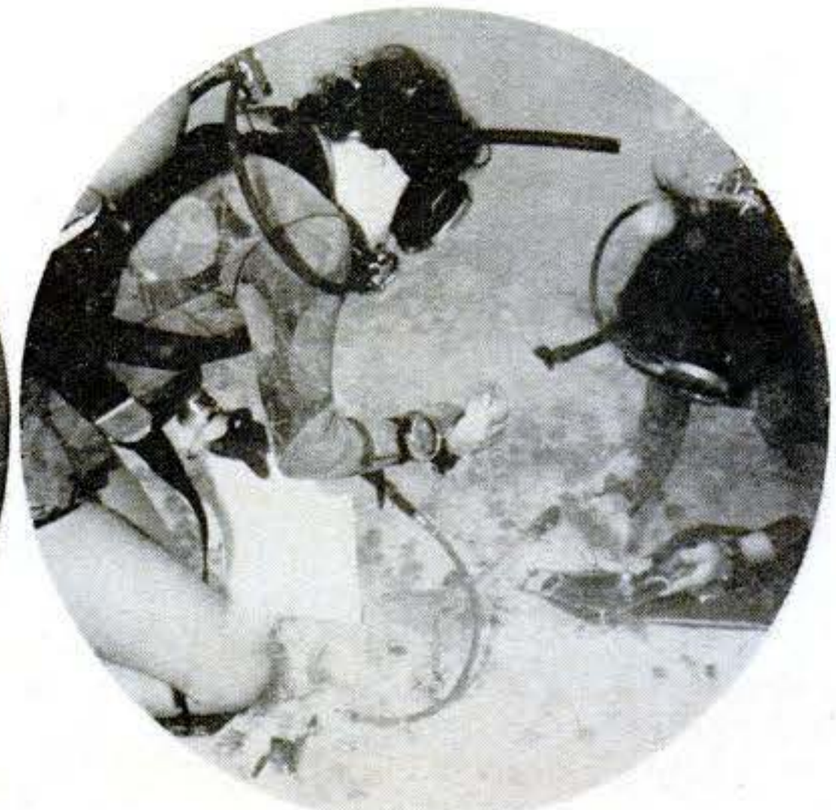
Our Consulting Editor for Oceans visits the 50-foot-deep habitat of the men and women at work on a new sea-floor experiment

Come Dive With Me to



Undersea glimpses show women aquanauts of Tektite II successfully carrying out a mission to study sea-bottom flora and fauna. Th

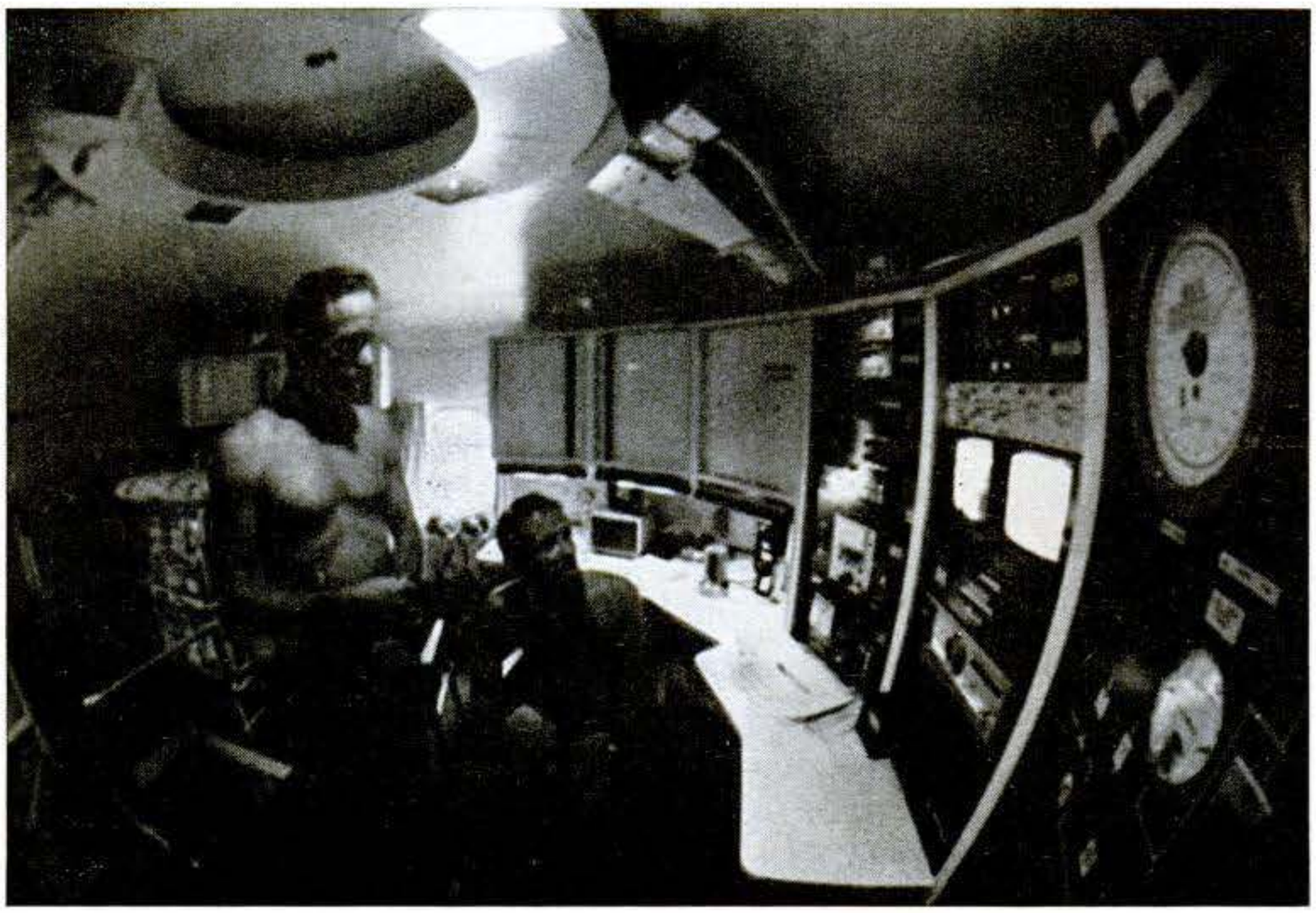
By CMDR. SCOTT CARPENTER, USN (RET.)

World-renowned astronaut and aquanaut

When the seven-month, 17-mission Tektite II program in the U.S. Virgin Islands is completed at this month's end, it will mark a new step forward in undersea adventuring.

Ten crews of five divers each will have spent up to 20 days at a 50-foot depth. Seven other crews of two men each will have lived 100 feet down for two weeks, if all has gone according to plan. Stays overlapping successive missions will have kept some divers under water for a month.

Last year at the same site—chosen for its warm and clear water—Tektite I's four aquanauts spent a record two months in a 50-foot-deep habitat ["Tektite Revisited," PS, Nov., '69].



On a visit to submerged habitat, Cmdr. Carpenter (left) is shown its control and communications center by John Van Derwalker, director of scientific programs.

This time, as many as 62 aquanauts are continuing and expanding the marine-science studies they began. Innovations in diving gear and techniques are being tested. Among Tektite II's many "firsts" has been the subsea debut of the first team of women aquanauts—"aquanettes" to some, "aquachicks" in Virgin Islanders' vernacular.

A first-hand view. To see what Tektite II was like, I traveled to the site, paid a 50-foot-deep visit to its main underwater habitat, and had an opportunity to watch its team of women aquanauts in action.

I timed my trip, near the end of June, to coincide with a crew change so I would be able to visit the GE-built habitat without interfering with the divers or their scientific programs. (Habitat visitors are not allowed, anyway, after the first day of occupation by a crew.) Permission for my trip was obtained from three of Tektite II's main sponsors—the Department of the Interior, General Electric, and NASA.

Tektite II's site is off St. John Island—a 30-minute boat ride from St. Thomas Island, usually under a blue sky and warm sun. The boat ties up near the Tektite II base camp, which normally houses 60 people. A short Jeep ride brings morning visitors to the chow hall in time for breakfast.

Some distance away on Beehive Cove is the Habitat Support Center. The main habitat, 800 feet directly offshore, is monitored and supplied with key services by this land base.

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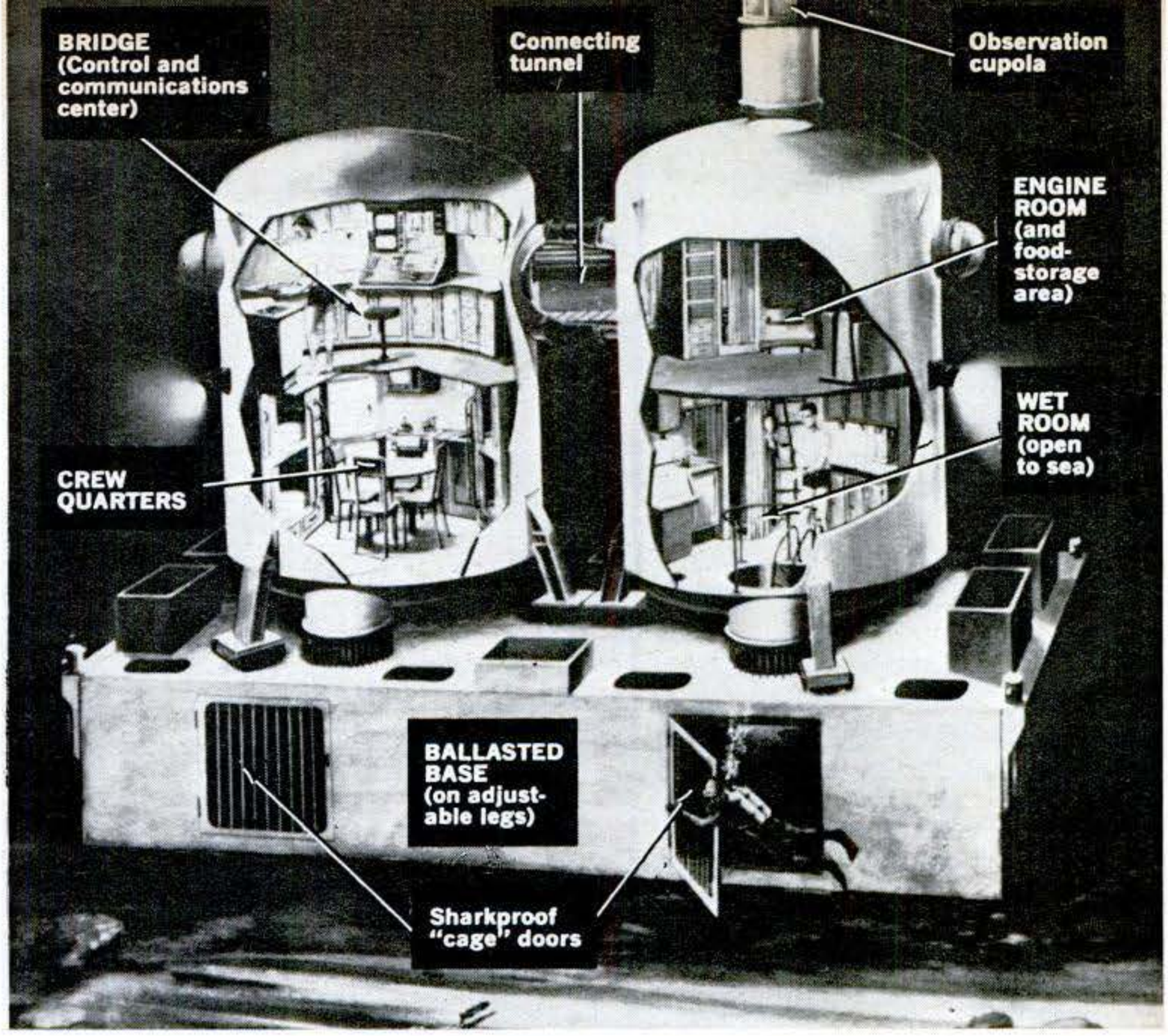
Tektite II

ehearsals for it gave author a vivid preview.



Tektite II habitat, 50 feet deep, accommodates crew of five for a stay of 14-20 days.

At a console in its control van, a watch officer and observers are in constant telephone communication with the habitat. TV screens show them what is happening in each of the habitat's compartments—and what is seen when aquanauts carry a camera outside. These displays can be video taped. Observers ashore can also listen in through open microphones in each habitat compartment.

At the shoreline are a diver-support pier and a support barge with decompression facilities on its deck. Also barge-mounted is equipment to supply the habitat from ashore with electricity, fresh water, and other needs, through an umbilical cluster of cables and hoses running along the sea floor.

A visit to the habitat. To get to the habitat, you swim out to it from shore, with scuba-diving equipment. For my visit I donned standard open-circuit scuba gear and swim fins. My guide was John Van Derwalker, the project's scientific-programs director, who has probably spent more time working in and out of the habitat than any other Tektite diver.

Starting from the support barge, we swam along the bottom toward the habitat. Its white bulk became visible a little less than 100 feet away. We reached it about five minutes after leaving the shore.

To enter the habitat, we swam into the open four-foot-diameter hatchway in the floor of its "wet" compartment for divers' use. Since the water pressure at the habitat's depth is exactly balanced by the 39.9-pound-per-square-inch pressure of its own atmosphere (or just a little more than double the pressure of the air you breathe), no water rises above the open hatch's level.

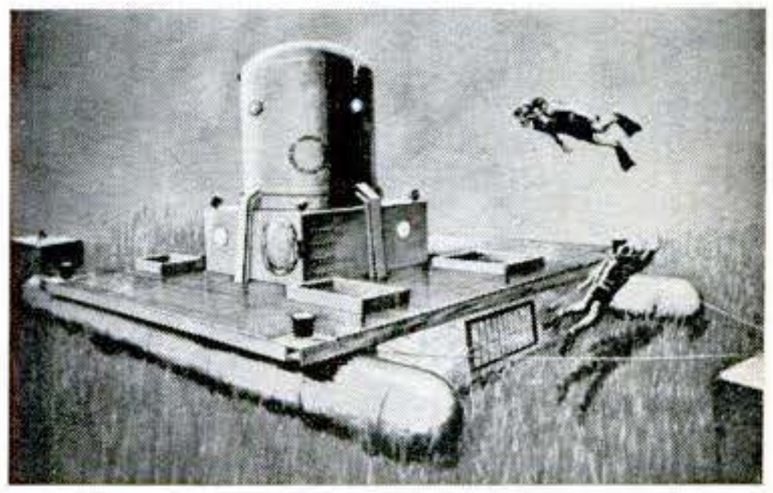
The five-man habitat consists of two 12-foot-diameter cylinders, each 18 feet high and divided into two compartments. Divers make their excursions from the wet room we first entered, which contains diving gear, a small lab, and a hot shower

The compartment above, rather fancifully called the "engine room," actually holds transformers, switchgear, food stored in a large freezer, and the environmental-control system that maintains the habitat's pressurized atmosphere of 93 percent nitrogen, seven percent oxygen

Through a 4½-foot-diameter tunnel, we passed from this compartment to the "bridge," the control and communications center in the upper part of the other cylinder The bridge provides a bunk for one member of the crew of five, its "engineer." The rest of the crew sleep in the compartment below, the crew quarters, which also serves as a living, dining, and recreation room. Windows in the sides of the habitat, and in an observation cupola projecting above it, give the occupants a view of marine life outside.

During our tour we saw several divers preparing the habitat for its next mission, and a photographer who snapped pictures of us.

When we swam back to shore after an hour's inspection of the habitat,



"Minitat," the 100-foot-down outpost of Tektite II for deeper experiments, is designed for a two-week stay by crew of two.

our dive to its depth had been too brief to require going through decompression for readjustment to normal atmospheric pressure. But it's a different story for the crew of an extended Textite II mission.

The personnel transfer capsule. After 24 to 36 hours of submergence at the habitat's depth, the crew members are "saturated"—their blood and tissues have dissolved the maximum possible amount of the pressurized gas they breathe. Returning them suddenly to sea-level pressure would release dissolved nitrogen gas in bubbles, and bring on the painful and dangerous "bends."

So, when a crew leaves the habitat at a mission's end, they swim to a point on the bottom beside the support barge, where the water is 40 feet deep. Still under pressure, they are lifted to the surface by successive trips of a "personnel transfer capsule," a spherical two-man diving

[Continued on page 142]

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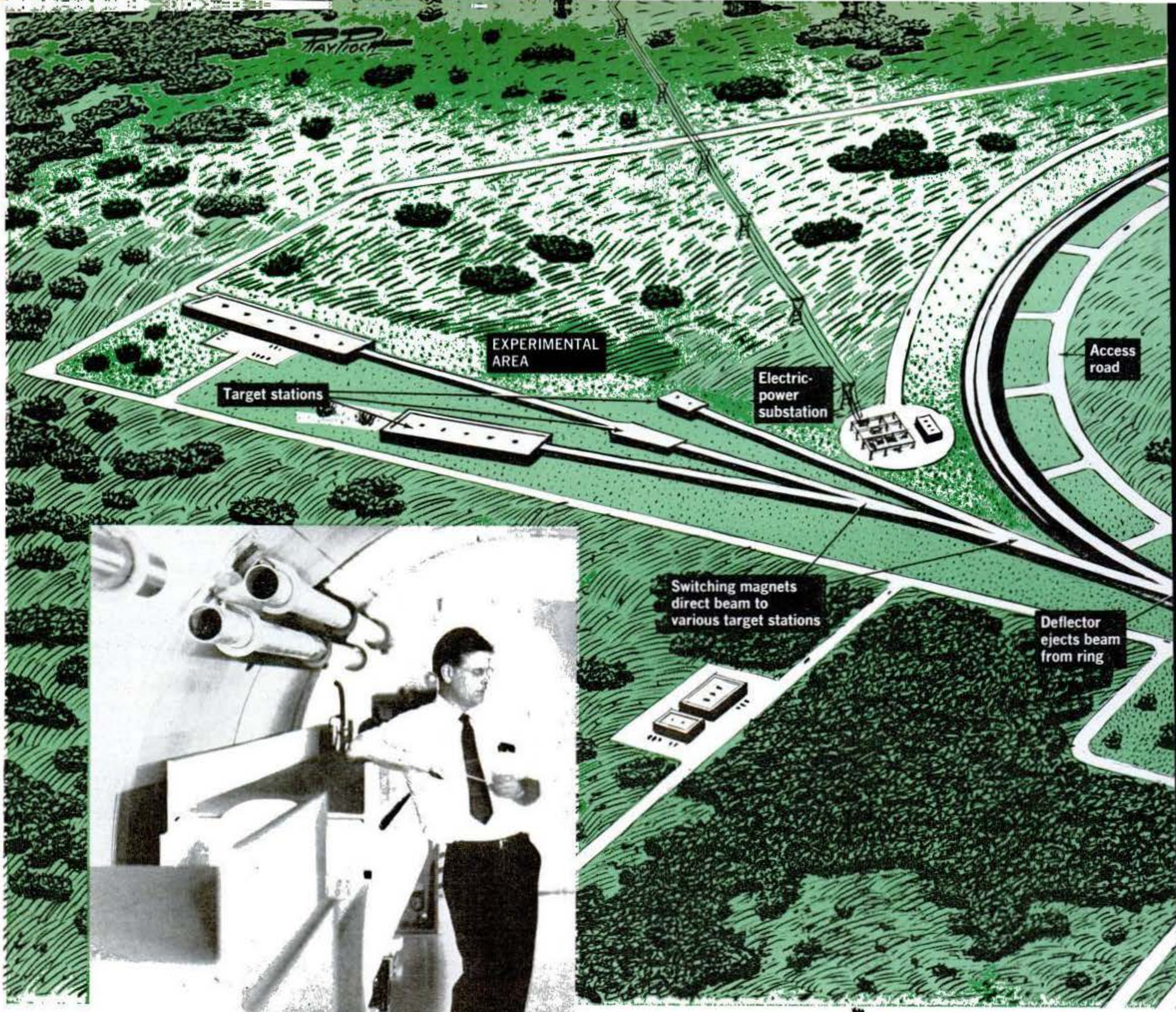
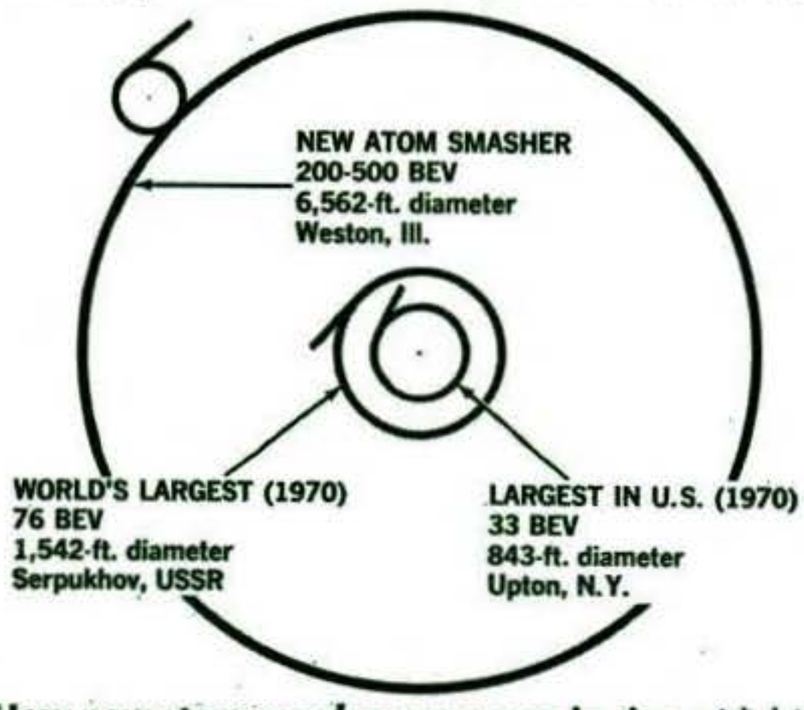


Boosting original design's power while slashing its cost was near-miracle achieved by Prof. R. R. Wilson, pictured in mock-up of section of ring.



How new atom smasher compares in size with biggest existing ones in world and U.S. is shown to scale above. Current record-holder is 76-BEV proton synchrotron of Institute for High Energy Physics at Serpukhov, in Russia. Next comes 33-BEV one at Brookhaven National Lab, Upton, N.Y.

YOUR PREVIEW OF THE World's

A spectacular 1¼-mile-diameter ring machine wielding 200 to 500 billion electron volts may bare the innermost secrets of matter

By ALDEN P. ARMAGNAC
DRAWINGS BY RAY PIOCH

This will be the colossus of them all—the mightiest atom smasher the world has ever seen.

Some 30 miles west of Chicago, the spectacular $250-million ring-shaped machine is well along toward completion for the new National Accelerator Laboratory at Weston, Ill. By recent announcement it may go into action as soon as mid-1971, a year ahead of schedule.

A mile and a quarter in diameter, it will be the biggest instrument on earth for basic research.

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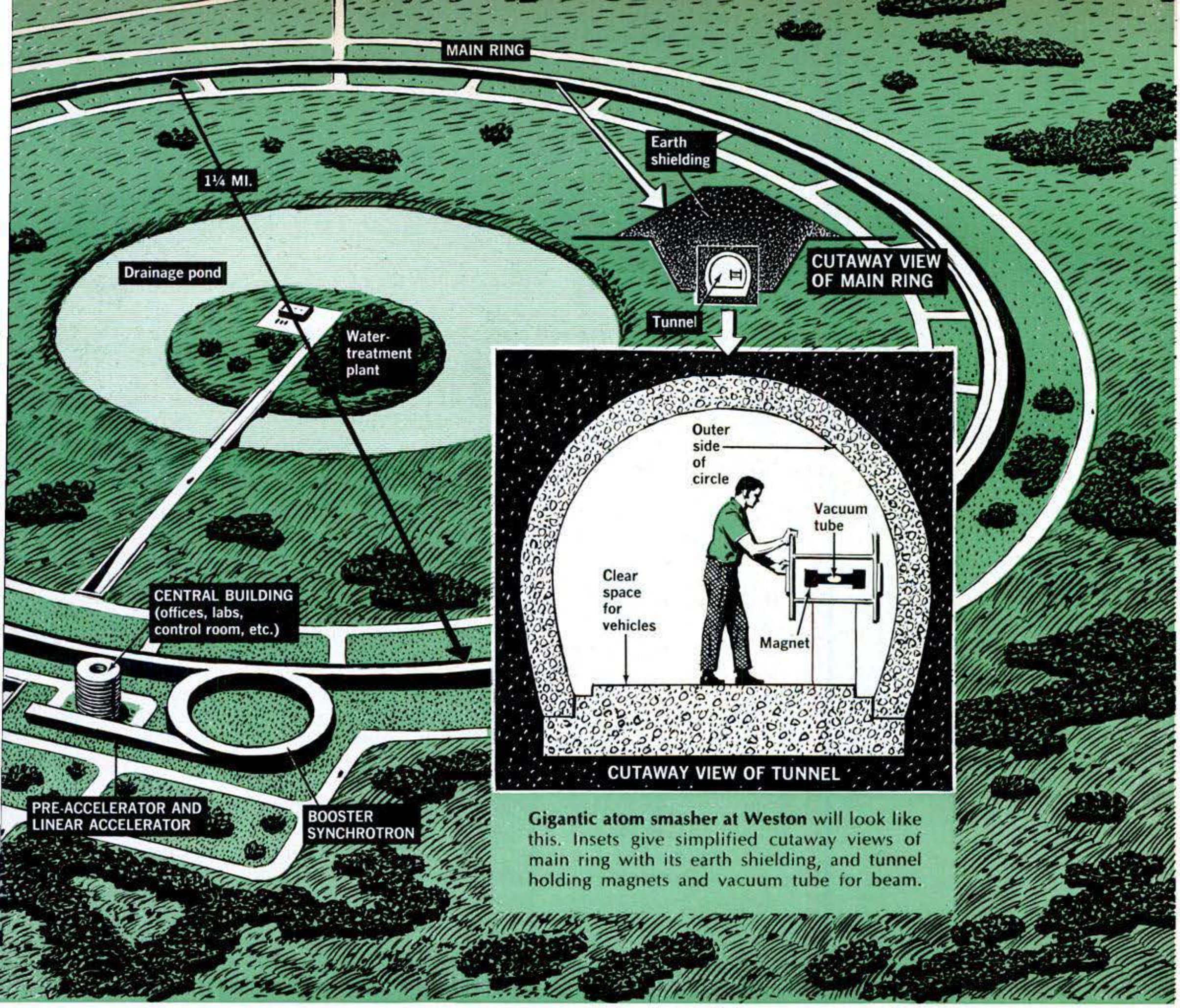

Gigantic atom smasher at Weston will look like this. Insets give simplified cutaway views of main ring with its earth shielding, and tunnel holding magnets and vacuum tube for beam.

Mightiest ATOM SMASHER

Largest appliance ever to be plugged into a commercial power line, it will run up an electric bill of something like $2 million a year.

Called a proton synchrotron, it will boost speeding protons—the cores of hydrogen atoms—to fantastic energies of 200 to 500 billion electron volts (BEV). That will bring back to America the record held since 1967 by a 76-BEV atom smasher at Serpukhov in Russia, the world's most powerful today.

Hurled out of the huge ring on a tangent, the Weston machine's atomic bullets will crash into targets at a speed of at least 99.999 percent of the velocity of light, to blast out the innermost secrets of matter.

Giant ring runs underground. At the 6,800-acre flatland site of the Weston accelerator, earlier this year, a visitor could see its gigantic main ring taking shape in a great ditch 20 feet deep, flanked by clanking cranes. Being lowered into the excavation were 10-foot sections of precast concrete that, aligned and joined end to end, would form a circular tunnel. Horseshoe-shaped in cross-section, the tunnel will be eight feet high and 10 feet wide. For shielding against dangerous radiation from the ring, a mound of earth 22 to 33 feet thick will cover it.

Already completed and successfully tested above ground last March, a prototype section of the endless four-mile-long tunnel gives a viewer an advance look at what is to go inside it.

Along an interior wall, on the side away from the ring's center, will run a continuous string of girder-shaped electromagnets—nearly 1,000 in all. They include "bending" magnets to make the stream of hurtling protons follow a circular path, and "focusing" magnets to compress the sausage-shaped clusters of speeding particles into a beam small enough to pass through the "barrel" of the atom gun without touching it.

Running between the magnets' poles, this "gun barrel" is a stainless-steel vacuum tube of surprisingly diminu-

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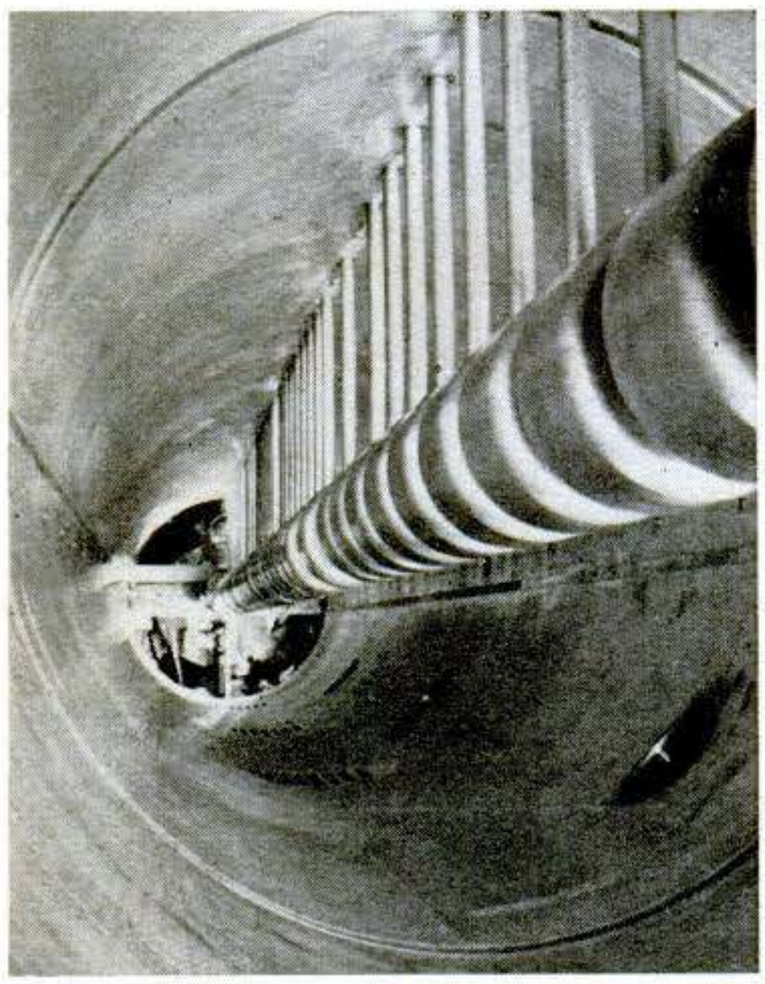
Four stages will boost atomic bullets to fantastic energy. First stage, pre-accelerator being assembled above, starts them on their way at 750,000 electron volts.



Linear accelerator 500 feet long, great machine's second stage, speeds up the particles—and they emerge from it with an energy of 200 million electron volts.

tive dimensions. Its oval cross section measures only two by five inches overall at the focusing magnets, and is even narrower or shallower at the others, conforming to predictable variations in the shape of the beam.

Vacuum pumps spaced every 50 feet will maintain about one 10-billionth of atmospheric pressure in the vacuum tube—so little that less than 1/10 of one percent of the orbiting protons will be lost by collision with the remaining air molecules.

Left in the tunnel by magnets and vacuum tube is a clear space more than seven feet wide. Special battery-powered electric vehicles, with pilot wheels engaging a guide rail in the tunnel floor, will run along this roadway. Designed expressly for the Weston machine, they will handle and install its 10-ton, 20-foot-long magnets—dispensing with overhead cranes for this purpose. They will serve for maintenance, too.

Four stages to orbit. Like rockets that put spacecraft into orbit, the biggest atom smashers are multistage affairs. The monster accelerator at Weston will be the first of them with as many as four stages:

Protons from electrically ionized hydrogen gas are started on their way by a Cockcroft-Walton "pre-accelerator" at 750,000 electron volts. A 500-foot-long linear accelerator, or "linac," hikes the particles' energy to 200 million electron volts. A ring-shaped "booster synchrotron" whirls them up to eight billion electron volts, and injects them into the main ring. There, a kick from accelerating electrodes, at each circuit, imparts their record-breaking energy of 200 to 500 billion electron volts.

Today's biggest atom smashers feed a main ring from a linac. The awesome scale of the Weston machine is emphasized by its added stage, the booster synchrotron. This eight-BEV, 500-foot-diameter accelerator itself will be one of the nation's most powerful—outranking the University of California's famed six-BEV Bevatron at Berkeley. It could be a potent atom smasher in its own right, but will serve solely as a feeder for the main ring at Weston.

Less than 2½ seconds will suffice to fill the main ring with protons and accelerate them to 200-BEV energy. In that brief time they will travel up to 500,000 miles, or 125,000 times around the ring—farther than to the moon and back.

When the orbiting protons reach the chosen peak energy—which may range from 200 BEV up to 500 BEV—an electrostatic deflector will divert them into a vacuum tube in a straightaway underground tunnel leading toward the experimental area. Along the way, powerful "switching" magnets will direct the beam to one or another of three experimental stations, to impact upon targets of materials like copper, carbon, and beryllium. Secondary beams of neutrinos, mesons, and other particles will stream off toward additional targets. Observers at such sophisticated apparatus as a 15-foot-diameter bubble chamber will photograph and study the atomic wreckage from the collisions.

Planners expect that a single operator will be able to control the entire machine, from pre-accelerator to experimental area, with the aid of TV displays of remote meters' readings and of components' behavior. The machine will be run from a control room in the Weston center's high-rise main building. This central building will also house offices,

[Continued on page 118]

Booster synchrotron of 500-foot diameter, seen under construction, is third stage. It whirls particles to eight billion electron volts, and serves as injector to feed them to main ring.

Fourth stage is 1¼-mile-diameter main ring, shown being laid in sections in its circular excavation. It accelerates the particles to fabulous energy of 200 to 500 billion electron volts.

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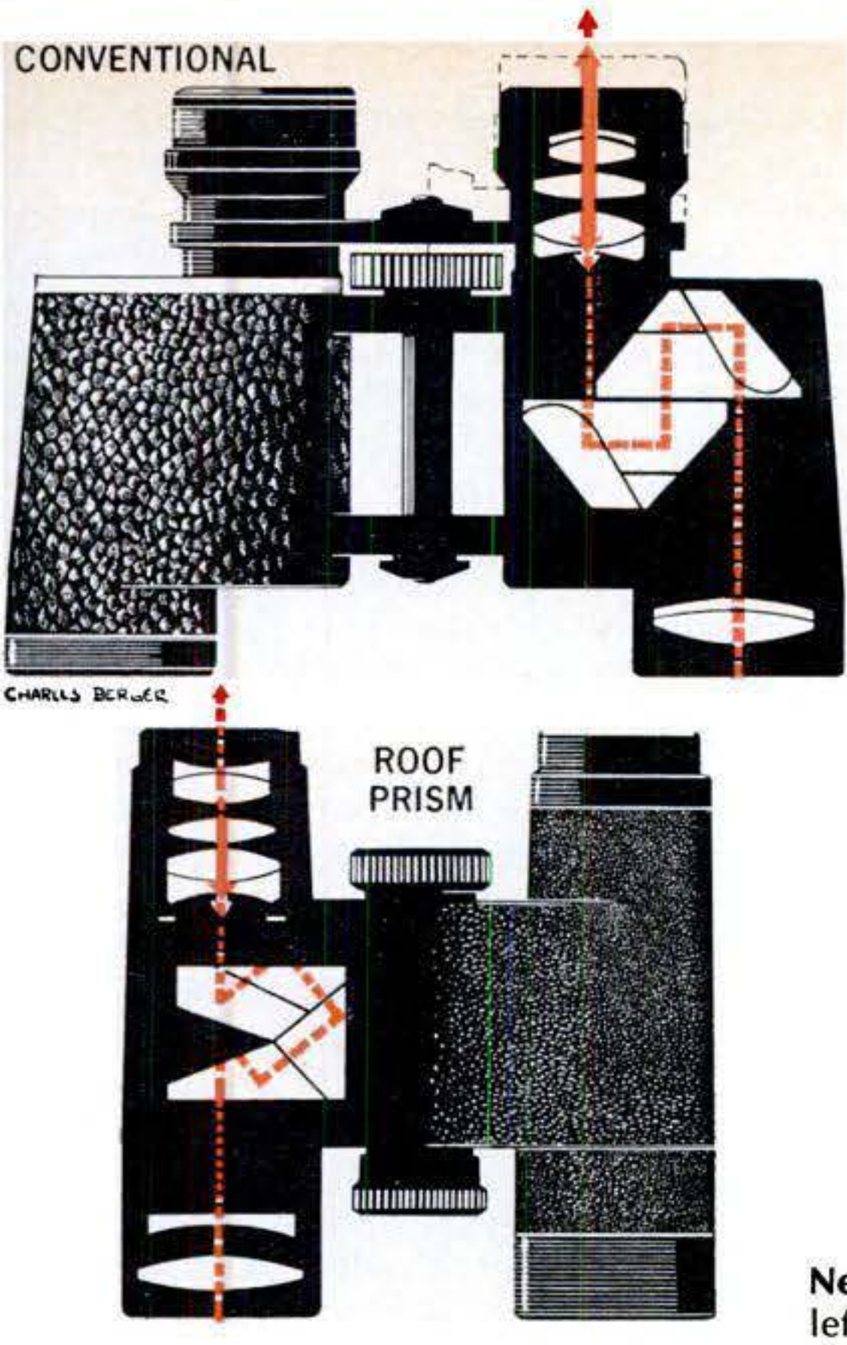
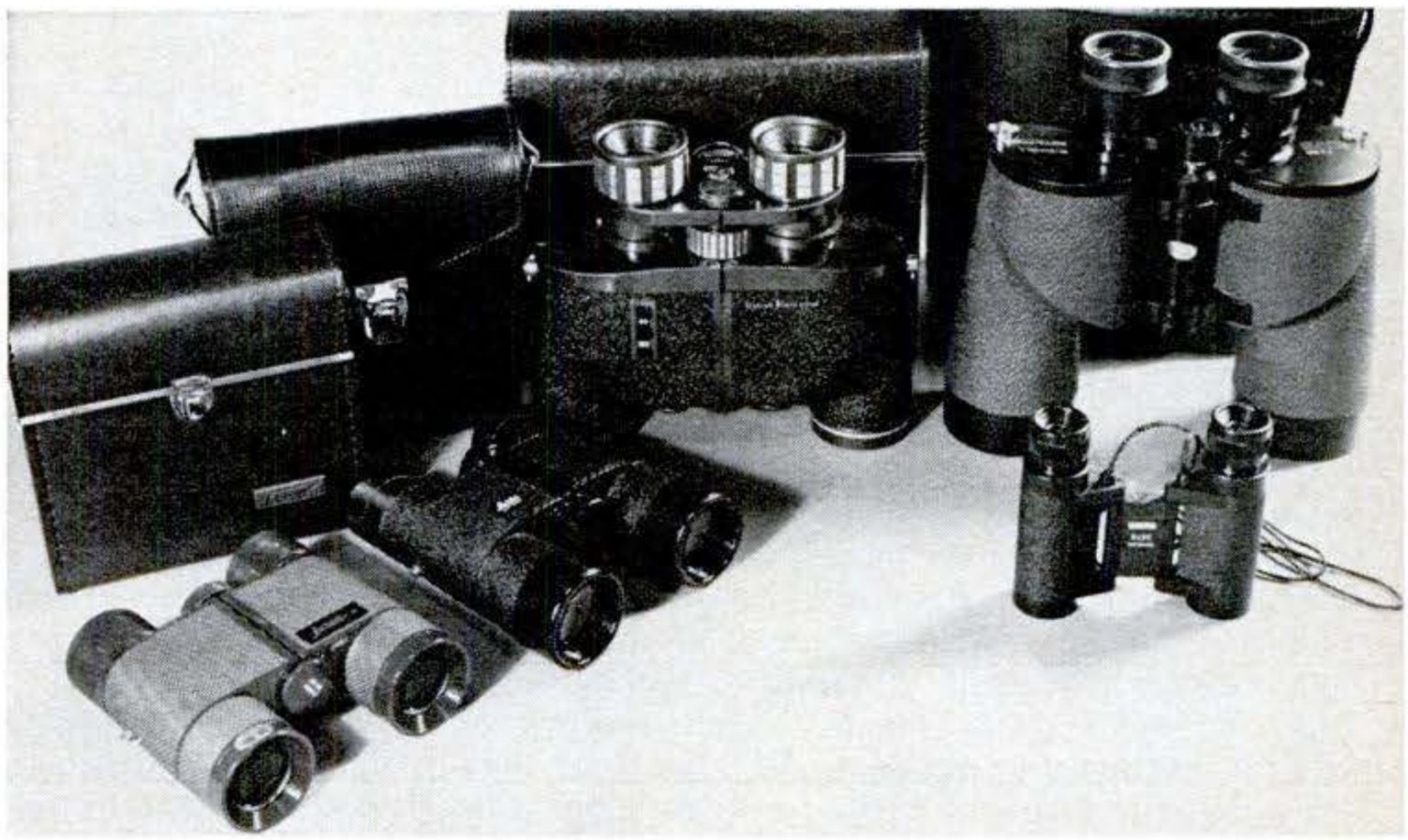


New roof-prism design (lower drawing, left) eliminates bulge inherent in conventional-prism binoculars. Result: lighter glasses—often a third less weight—and a slimmer profile. Swift's 9X35 Trilyte above is a lightweight, 20-ounce example.

A Close-up Look at the New BINOCULARS

They're smaller, lighter, slicker than ever—in the widest selection yet seen

By PHIL McCAFFERTY



Author tested (left to right) Jason/Empire 7X28 roof prism; Leitz 7X35 roof prism; Jason/Empire power zoom; Bushnell 7X50; and Zeiss 8X20 minis with Pechan prisms.

When Armstrong, Aldrin, and Collins blasted off for the moon in Apollo 11, they took along half a pair of unconventional binoculars with roof-prism optics. Their modified Trinovid 10x40 instrument was chosen, says maker Leitz, "for its combination of power, clarity, mini-size, and durable construction."

You may not be planning a trip to the moon, but now's a good time to shop for binoculars. Recent design advances have made binoculars better than ever, and never before has there been such a great variety available. Look at the lineup:

Roof-prism designs. They have a slim "H" shape—minus the offset bulges required by the prism arrangement in conventional binoculars. The illustrations above at left show how the roof-prism design beats the bulge while retaining the advantages prism binoculars have over non-prism glasses: By folding the light path, they give you greater power in a smaller package.

Other well-known roof-prism brands besides the Leitz Trinovid are Swift's Trilyte, Jason/Empire's Minitron, and Zeiss's Dialyt. The Sears model is Slim Silhouette. Focal calls theirs Wide Compact and Slim Line.

Are they really better? One maker points out that roof-prism glasses are more durable because the cemented, three-prism (the center one is the "roof" prism) system is much more readily locked into permanent alignment than Porro prisms—the conven-

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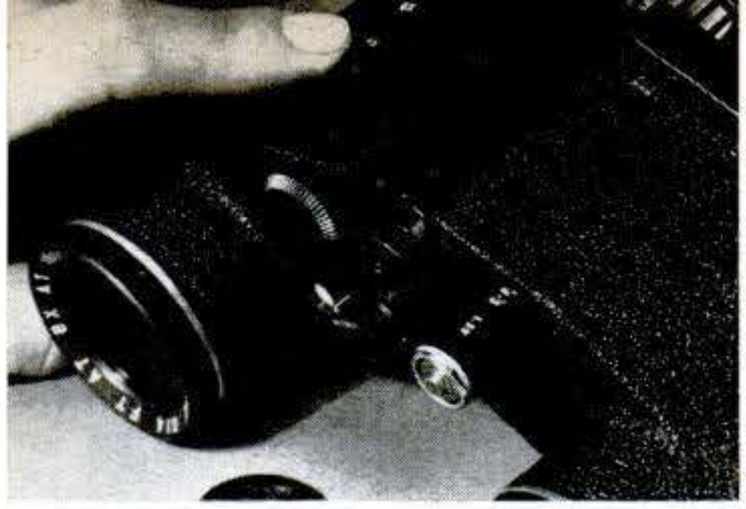
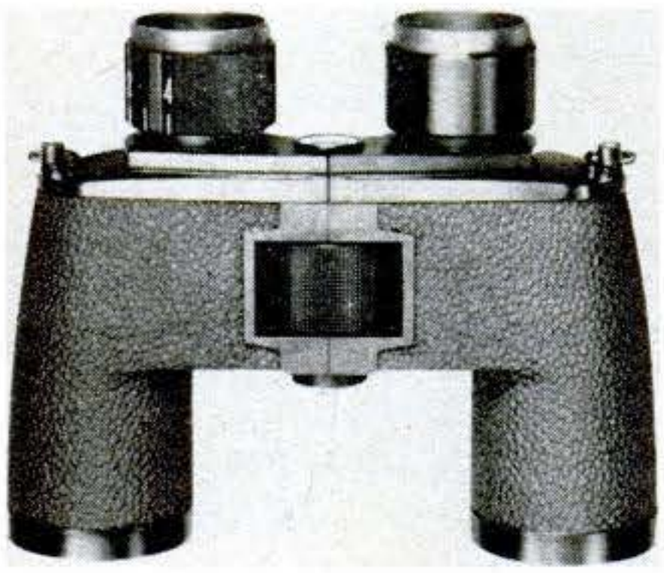


Power zoom, run by batteries, gives six power at lowest setting, zooms to 12 when you need it. Glasses here are Jason/Empire.



Slick new styling around conventional optics is typified by these 7X35 Bushnells

tional ones. The Trinovid, for example, focuses internally—probably a durability plus. Some others have semi-internal focusing. Mini-size 10x40s are only about 5½ inches long, under five inches wide, and weigh only a shade over a pound. Conventional binoculars of this size would weigh perhaps four pounds and be half again as big. Many lower-power roof-prism glasses are, of course, even slimmer and lighter.

Porro-prism types. Roof-prism optics haven't changed the whole binocular industry. Far from it. Practically everyone who sells roof prisms also has conventional binoculars.

Even binoculars that *look* outwardly the same may be different. Improved lens coatings give sparkling-bright images. Light metals reduce heft.

Most binoculars used to be either "American pattern"—one-piece barrel housings—or "German pattern"—two-piece housings. The new design trend is toward one-piece barrels with bold new styling and convenience features such as large, easy-to-operate focu wheels.

To make binoculars even handier several models are offered with quick thumb-lever focusing. And, of course there are zoom optics—electric and manually operated—that change magnification instantly from moderate to high.

A large number (almost half the models one maker sells) of today's binoculars have wide-angle optics. A a given power they include a wide area in the view.

Minis and compacts. Palm-sized prism glasses—sport glasses—have been around for a long time, usually with just enough housing to cover prisms and lenses. Now they're rounded out with big binocular-style housings. Many have wide-angle optics as well.

Bushnell has a 6x25 and a 7x35 only 3⅛ inches high. United's featherweight 30mm mini floats on water Nikon's scant-handful 7x21 has objective lenses protected by optical plate glass. Jason/Empire's 6x18 is 2¾

10 Things to Look for When You Buy Binocula

Binoculars are not all the same. Good ones are a lifetime joy. But watch out for those real inexpensive glasses. They may make your eyes water as much as the price made your mouth water.

As price increases, so do your chances of getting better lenses, higher-quality prisms more carefully installed, better lens coatings, stronger hinges and mechanisms, better sealing against dirt and moisture, nicer carrying cases, and maybe lighter magnesium barrels.

Shopping for binoculars takes time—you should compare several different brands and types to get a good idea of what you want, and what kind of quality you can expect for the money you're prepared to spend. Here is a list of things to look for:

1. Power, size, field of view. Take 7x35 binoculars. "7x" means objects will be magnified seven times. "35" is the millimeter diameter of the front, or objective, lenses. For most uses, six- to eight-power glasses are the popular ones. Higher power (up to 16 power is generally available) is useful for very long, open spaces, and usually requires tripod mounting. Zooms are a way to satisfy occasional need for high power. Field of view is expressed in feet of view at 1,000 yards distance. It's a product of magnification and eyepiece optical design.

2. Brightness. This is expressed either in terms of "exit pupil" (objective-lens diameter divided by power) or "twilight factor" (square root of objective-lens diameter times power). The higher the number, the greater the brightness. Get all the low-light efficiency you can, but don't let that be the only deciding factor. In daylight, many models will pass more light than your eye will admit. A large exit pupil is a definite advantage when glasses are used from a boat or moving platform. It permits a broader shaft of light to emerge from each of the eyepieces. On a rough ride, it's easier to keep that wide shaft shining into your eyes than a narrow one.

3. Image quality. No binoculars eliminate all aberrations. The degree of their reduction is the measure of image quality. Try the following checks. *Image distortion:* Focus on a building or object with straight lines and square angles. Check lines near edge of field for bad curving. *Curvature of field:* Image is sharp at center but blurred at edges. (In some binoculars it is not possible to get sharp edges in any focus, due to other aberrations.) *Chromatic correction:* In poor glasses, you'll see bright color "fringes" around the edges of a building, post, or tree silhouetted against the bright sky. *Overall comparative evaluation:* Sight a license plate or chain-link fence several blocks away. Compare. (Never evaluate through a window glass.) Indoors, with binocu of equal power, move back until y can't quite read the small type o newspaper. The one that enables y to read at the greatest distance has best definition.

4. Alignment. Your eyes will strain compensate for optical misalignm between barrels. Unless it is so b that you see double images, you m only have an uneasy feeling of disco fort. Prolonged viewing may produ eyestrain, headaches, even nausea. this: On a tripod or windowsill, pick

Wear glasses? If you do, you'll like th soft roll-back eyecups. They let you ge full-field view, when they're retracted.

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nches high and has a 578-foot field t 1,000 yards.

Optics, colors, features. Zeiss has leveloped a "Pechan" prism system hat puts the whole viewing system in ine in a straight barrel. It doesn't ave even the inward bulge of the roof rism. Full sized, the Pechan system s used in their 8x30B Dialyt binocu-ars. Miniaturized, in-line design risms show up in their bulgeless x20 mini (shown in a photo).

Should you color binoculars black? Not always. Some new Swift models re charcoal gray. Some Jason/Em-pire binoculars turn up "Tampico" rown. One Zeiss model, completely ubber-armored, is olive green. The ame color is used on a K-Mart/Focal nodel. K-Mart also offers a bright lue job.

One of the nicest things binocular nakers are doing is equipping more nd more instruments with retractable yecups. Made of rubber you turn ack, or screw-out plastic, they cor-ectly space your eye from the eye-iece lenses. Because the glasses are shorter when retracted, the eyeglass wearer can enjoy a full-field view; oth-er binoculars can't be brought close enough to give the same full field.

Which one for you? Binocular prices today range from under $20 to about $500. Most are sold at dis-counts, so shop around. But remem-ber, you usually get what you pay for.

Let's take a look at five models that represent major advances in binocular design, and see how they stack up. (For explanations of terms used, see section "10 Things to Look for When You Buy Binoculars.")

Leitz Trinovid 7x35B. $290. 18.3 oz. Exit pupil, 5mm. 450′ field. Twilight factor, 15.8.

These premium-priced roof-prism glasses have the look and feel of class. I like the soft rubber eyecups and the quick-snap neck strap fastener lugs. Center-focus wheel and right-hand ocular diopter adjustment wheels are located at either end of the center hinge and can easily be worked with the fingers of one hand. These wheels are the only external moving parts. I compared the roof-prism glasses optically with a well-known conventional-prism glass of the same power, and with almost identical wide field. I prefer the Trinovid for excel-lent flatness of field and crisp contrast. The heft (a third less weight) and size (three inches narrower) im-pressed me after a day in the woods.

Jason/Empire #107 7x28 Minitron wide angle. $99.50. 14 oz. Exit pupil, 4mm. 525′ field. Twilight factor, 14.

This is a good example of a low-priced roof-prism binocular. Mechan-ical quality and appearance may be a shade better than average for the price level. Center focus is handy, but, unlike the much more expensive Trinovid eyepiece, barrels telescope externally and diopter adjustment re-quired eyepiece rotation, as most con-ventional binoculars do. I like the wide field. Optically, this glass seems at least par for the price. Competi-tively, it has price, looks, wide field, twilight factor going for it.

Bushnell #11-7504 "Insta-Focus Featherlight" 7x50. $79.50. 41 oz. Exit

[Continued on page 138]

ect near the top of the field and if it changes position when viewed rnately through each barrel. Does ant?

Workmanship. Look carefully into objective lenses for poorly clamped ms (on economy glasses they may be glued on), blobs on the barrel ing, burrs. Shake to check for loose s inside. Outside, look for nicks, rly polished parts, bad alignment. ng the barrels on the center hinge. movement should be smooth— enough to hold a setting, soft ugh to change easily.

Focusing mechanism. Center focus /or eyepieces should rotate firmly and smoothly. Roughness or looseness probably means the binoculars are poorly protected against moisture and will wear quickly. Lots of grease on ex-tended eyepiece barrels may indicate how smoothness is achieved.

7. Lens coating. Air-to-glass optics are coated to reduce glare and reflec-tions, and transmit more light. Test by catching an overhead white fluorescent tube in the objective and eyepiece. You'll see a reflection from each ex-ternal and internal optical surface. Coated surfaces reflect amber, blue, or magenta images. White image: uncoat-ed surface.

8. Feel. The best binoculars can real-ly only be determined by comparison. They simply feel "right." Balance is right, controls convenient, grip and viewing comfortable.

9. Special features. Choose things like variable magnification, small size, fast focusing, and retracting eyecups for their usefulness to you, not simply for gadget value.

10. Maker and dealer. To compare glasses, pick a dealer who'll let you try before you buy. You may want to place your trust with camera/lens/photo equipment brands you've had experi-ence with. Check guarantees. They vary in terms of repair and replacement, and in length from days to "life."

vature of field (exaggerated here) is easy to spot. Focus the ses so the center of your view is sharp; the edges will re-n fuzzy. Stay away from binoculars with this defect.

Fast-focus feature must be smooth and conveniently located to be valuable. On these Bushnells, a thumb-operated lever does the job nicely—faster than center focus, and nearly as precise.

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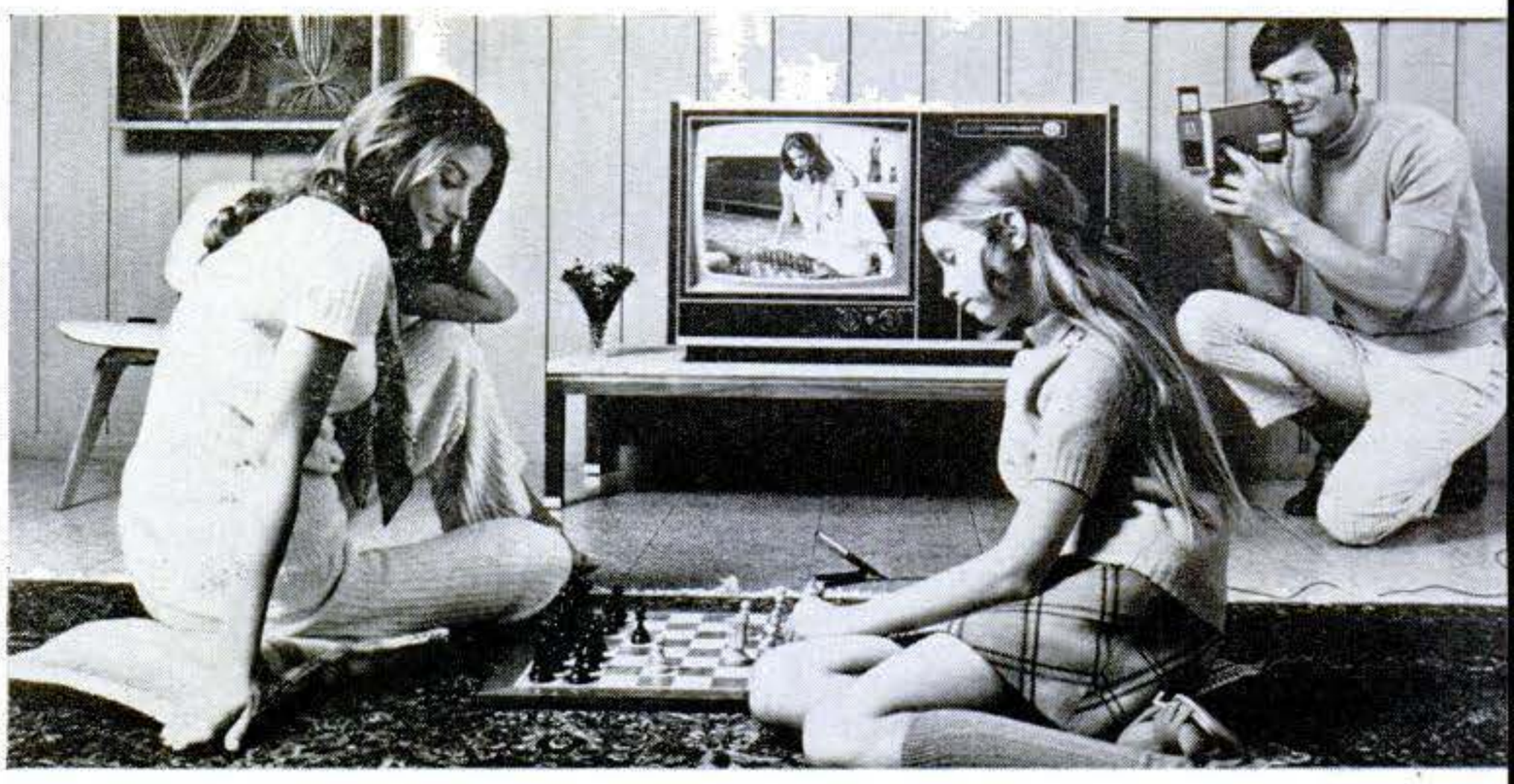
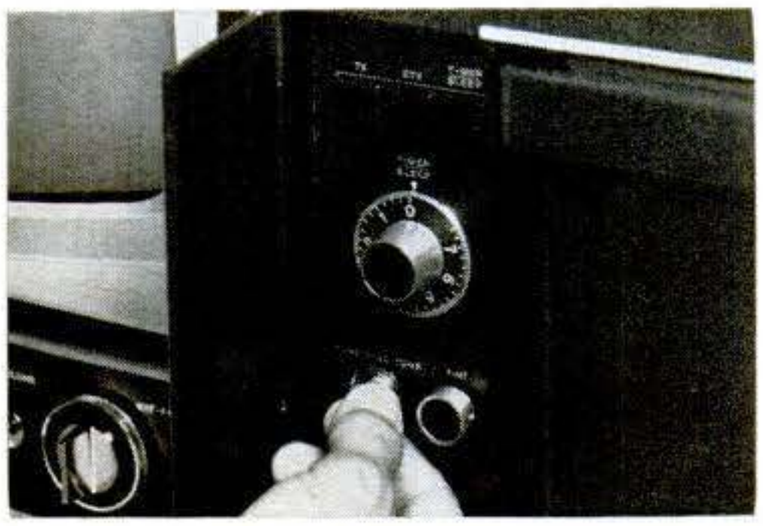
For COLOR TV: A Player, Recorder,

Black-and-white TV camera lets you make "instant home movies." With tape, there's no waiting for the film to be processed.



TV screens tapes as you shoot them. It's a great way to study your camera technique



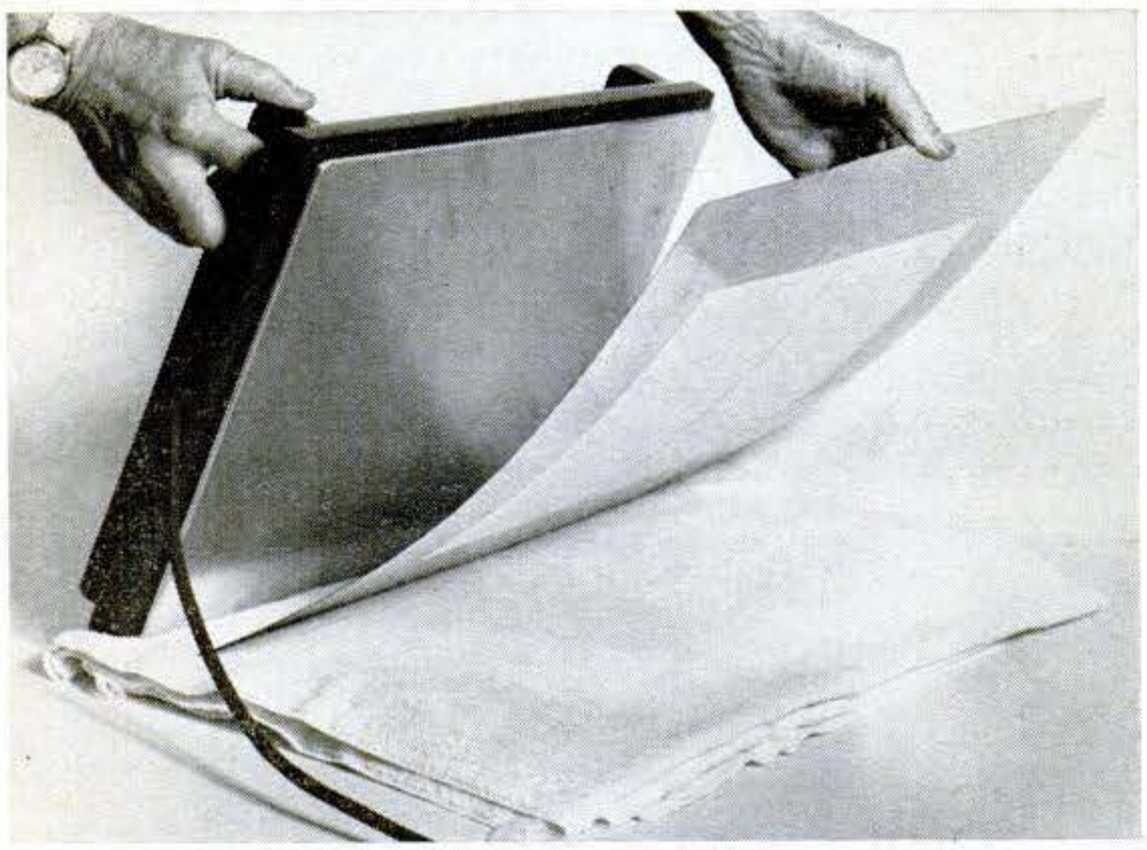
Set the timer on the Cartrivision recorder and it automatically records that favorite program you'd miss while away from home.

Everything is there—from the hardware to a library of prerecorded tapes

Take a complete cartridge-tape hi-fi system. Anything it can do, the new Cartrivision system can do. Except that cartrivision does it with color TV as well as with sound.

Cartrivision was developed jointly by Avco and Admiral. It's a complete video-tape system, with everything from the hardware to the program material. It features:

- A color record/playback unit built into a 19-inch color TV.
- Or a record/playback deck that hooks into your present color TV.
- A black-and-white TV camera with microphone for take-'em-yourself sound "home movies."



For glossy prints, lay the ferrotype plate face down on towels, and place the hot dryer on top. Prints are dry in minutes.

Stand-on-it system creates all the pressure you need for dry-mounting, does away with yokes that limit mount and print size.

Print Dryer Dry-Mounts 'Em, Too

Ever wait impatiently for a batch of prints to dry—wishing you had a print dryer? Or watch as the edges of those prize 11-by-14s you mounted with your wife's iron begin to lift off their mounts—wishing you had a real dry-mounting press? Now there's a new tool that both dries and mounts your prints. It's the Caltura dryer/mounter. Basically it consists of a unique heating film laminated to an aluminum platen. A thermostat lets you adjust the platen temperature to dry and mount both color and black-and-white prints.

You dry prints on a few layers of old towels. Lay them face up on the towels, cover with a layer of cotton sheet, and place the dryer on top of everything. To ferrotype the prints for glossies lay the tin face down on the towels and cover with the dryer. You get flat, dried prints in about two minutes. The 13-by-18 platen handles two 8-by-10s or one 11-by-14 at a time, and dries larger prints a section at a time.

As a mounting press, the Caltura is as outstanding as it is unusual. You stand on it to generate bonding pressure. This sounds primitive, but it works. I used the press to correct sloppy mounting jobs I did years ago. It flattened out bubbled and wrinkled prints, bonding them for good. And since the device has no pressure yoke, there's no limit to the size of prints or mounting boards it can handle—it will even mount giant photo murals a section at a time. The Caltura dryer/mounter is $79.95 at photo shops.—*A. J. Hand*

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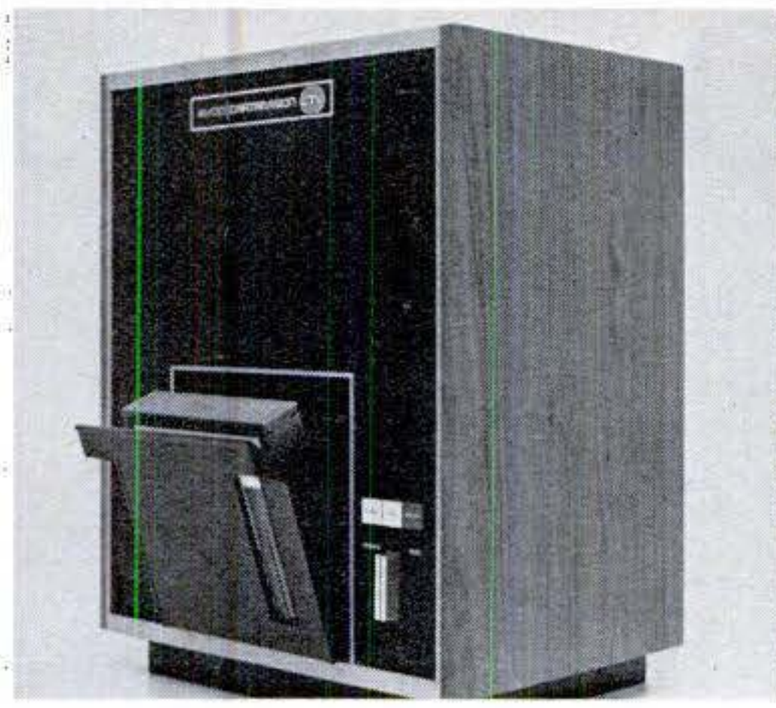
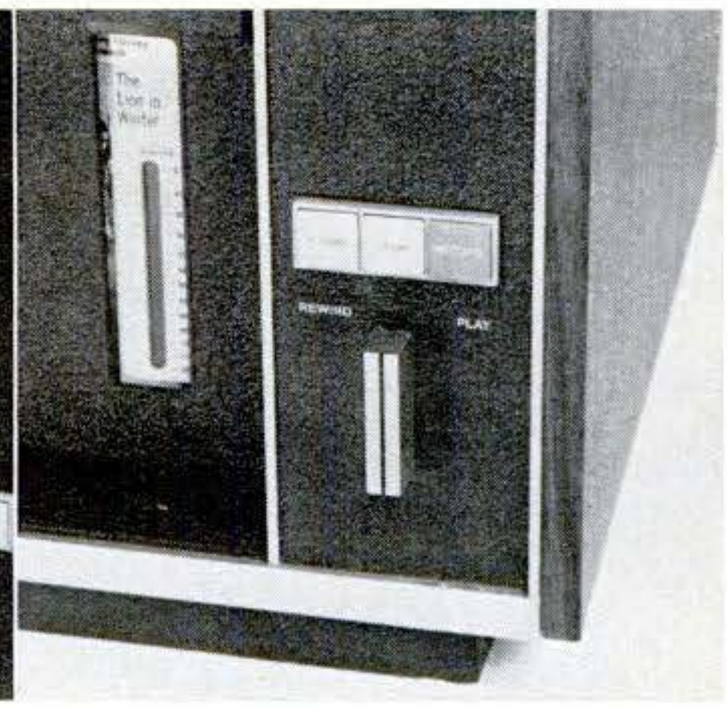
Do-Anything Cartridge System



Solid-state Cartrivision tape deck hooks into conventional color TV, adding record/playback capabilities for around $450.

Slip a rented full-length feature movie on cartridge tape into the player and sit back for a private night at the theater.



Controls like those found on standard tape recorders mastermind functions. Note time scale on cartridge in window at left.

• A complete range of prerecorded tape cartridges you can buy or rent.

It's this last feature—prerecorded tape cartridges—that gives Cartrivision its great potential. Of course you'll be able to record material, off the air or through the camera, on blank cartridges. But in addition, you'll be able to buy the Cartrivision recorder/player knowing there's a wide range of program material available to run through your system.

The prerecorded material comes in two types: sale and rental. For your rental money you'll get a choice of full-length American and foreign movies, from old Bogie classics to the latest releases—cartoons, Shakespeare, and more.

Cartridges you buy cover a much wider range of topics: golf lessons, art lectures, how-to-do-it techniques, underground movies, sports highlights, cooking lessons—enough material to form a complete TV library on tape.

What does it cost? Cartrivision is scheduled to hit the market early next year. Projected price for the recorder/player/monitor unit is around $850. The black-and-white camera (color is on the way) will be around $200. The recorder/player, without built-in TV, around $450. Cartridges will rent for $3 and up. They will sell for $10 to $25 blank and $8 to $25 prerecorded, depending on length.—*A. J. Hand*

The BINOCULARS with a Photographic Memory

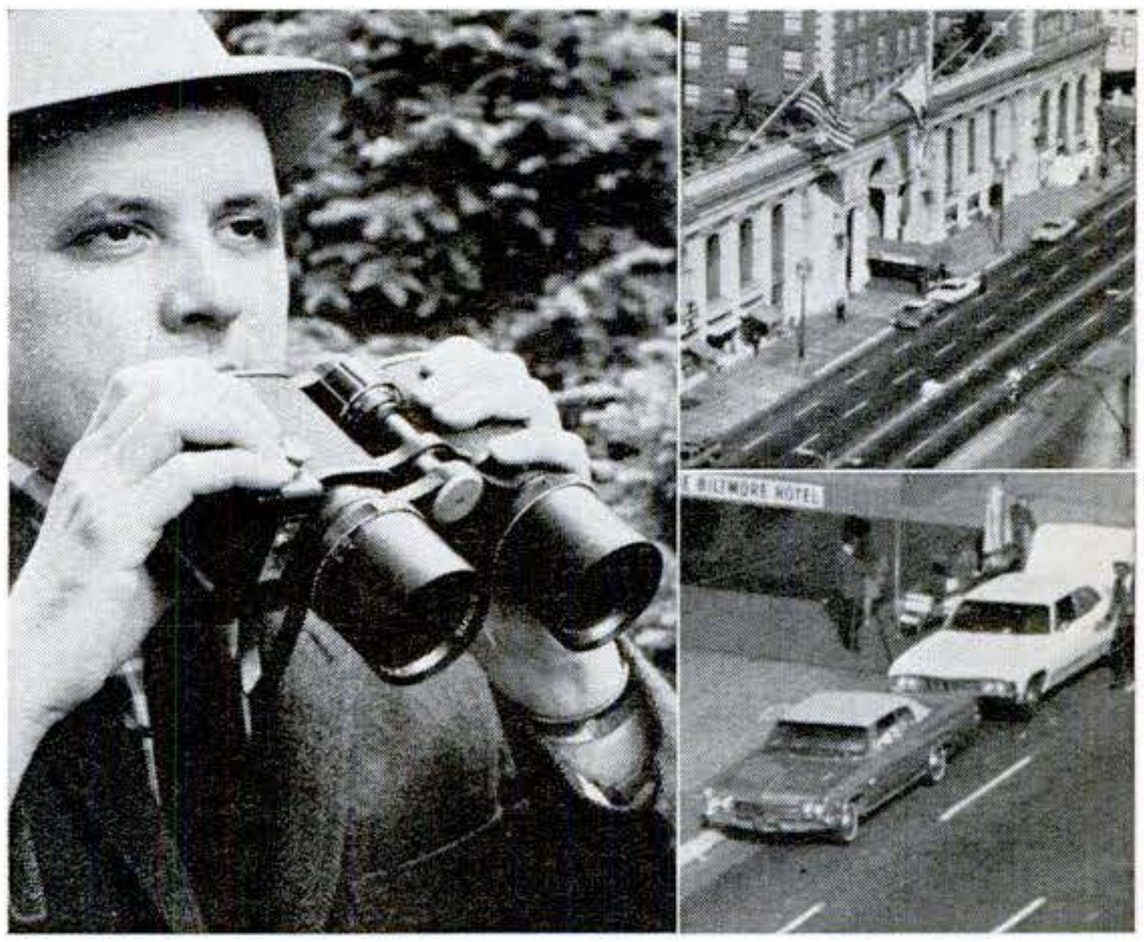
Whether the birds you watch are feathered or bikinied, there have probably been lots of times when you wished you could take a picture with your binoculars. With the new Nicnon, you can. It combines a high-grade 7x50 binocular with a camera.

The right half of the binoculars is a 35mm half-frame camera with shutter speeds of 1/60, 1/125, and 1/250. Aperture settings range from f/3.5 to f/11, and you can focus from 60 feet to infinity.

Wildlife and sports enthusiasts will appreciate the camera's spring-motor drive. It automatically cocks the shutter and advances the film after every shot, so you can fire off a shot a second.

Instead of the usual framing, you center cross hairs on your subject. The viewing angle is a little over six degrees, but you get about 10 degrees in your pictures. After running a lot of film through the Nicnon, I'm impressed. Picture quality rivals that of a first-class 35mm camera. Part of this is due to the Nicnon's 3¾-pound weight. This is about 25 percent heavier than the average 7x50 but it combines with the Nicnon's excellent balance to make rock-steady holding easier.

The Nicnon is made in Japan, and distributed in the U.S. by Walcam Enterprises, 412 W. 6th St., Los Angeles, Calif. 90014. Price is $320.—*Paul Wahl*



Wahl tested Nicnon in the country and the city. Compare shot on top, by regular half-frame camera, to one below, by Nicnon.

Half-frame camera takes standard 35mm cassettes. You get 40 shots on a 20-exposure roll, 72 on a 36. Note aperture ring.

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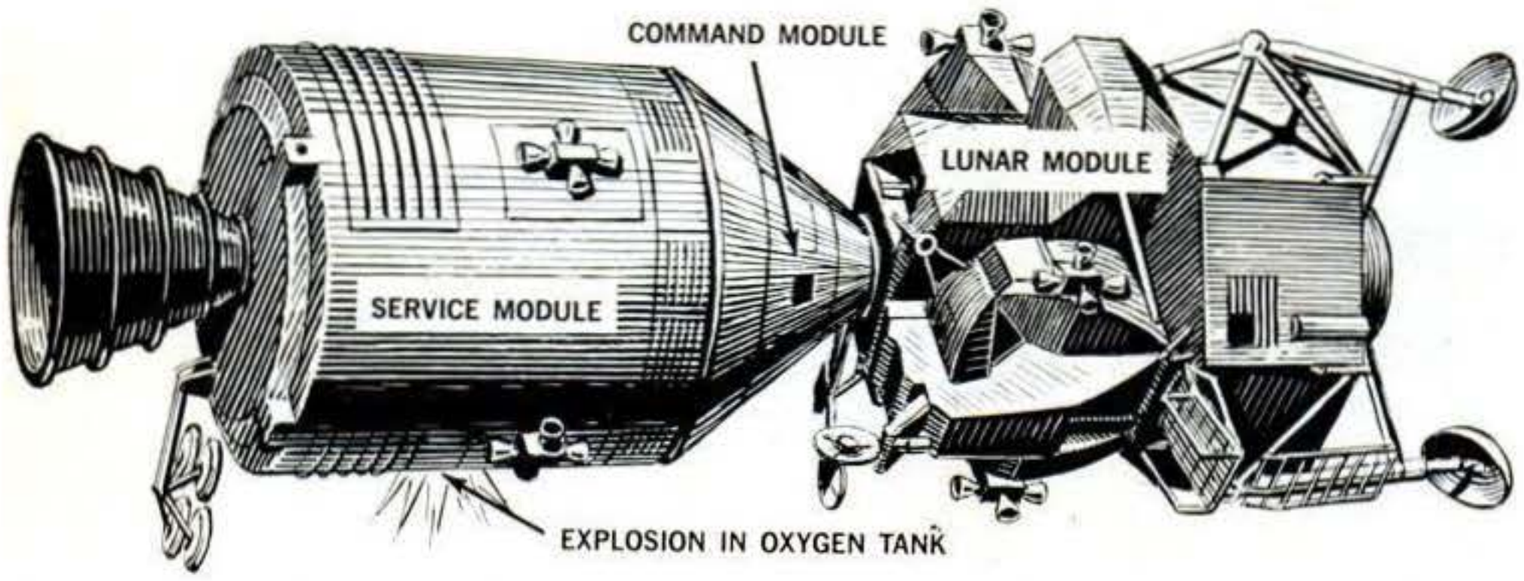
At Last—the Real Story:

WHY APOLLO 13



When Apollo 13 failed: Lunar module pilot Fred Haise was in the LM; command module pilot John Swigert was in the CM; Cmdr. Jim Lovell was in the tunnel between.

By C. P. GILMORE
PS Consulting Editor, Science

"Okay, Houston, we've got a problem here."

"Say it again, please."

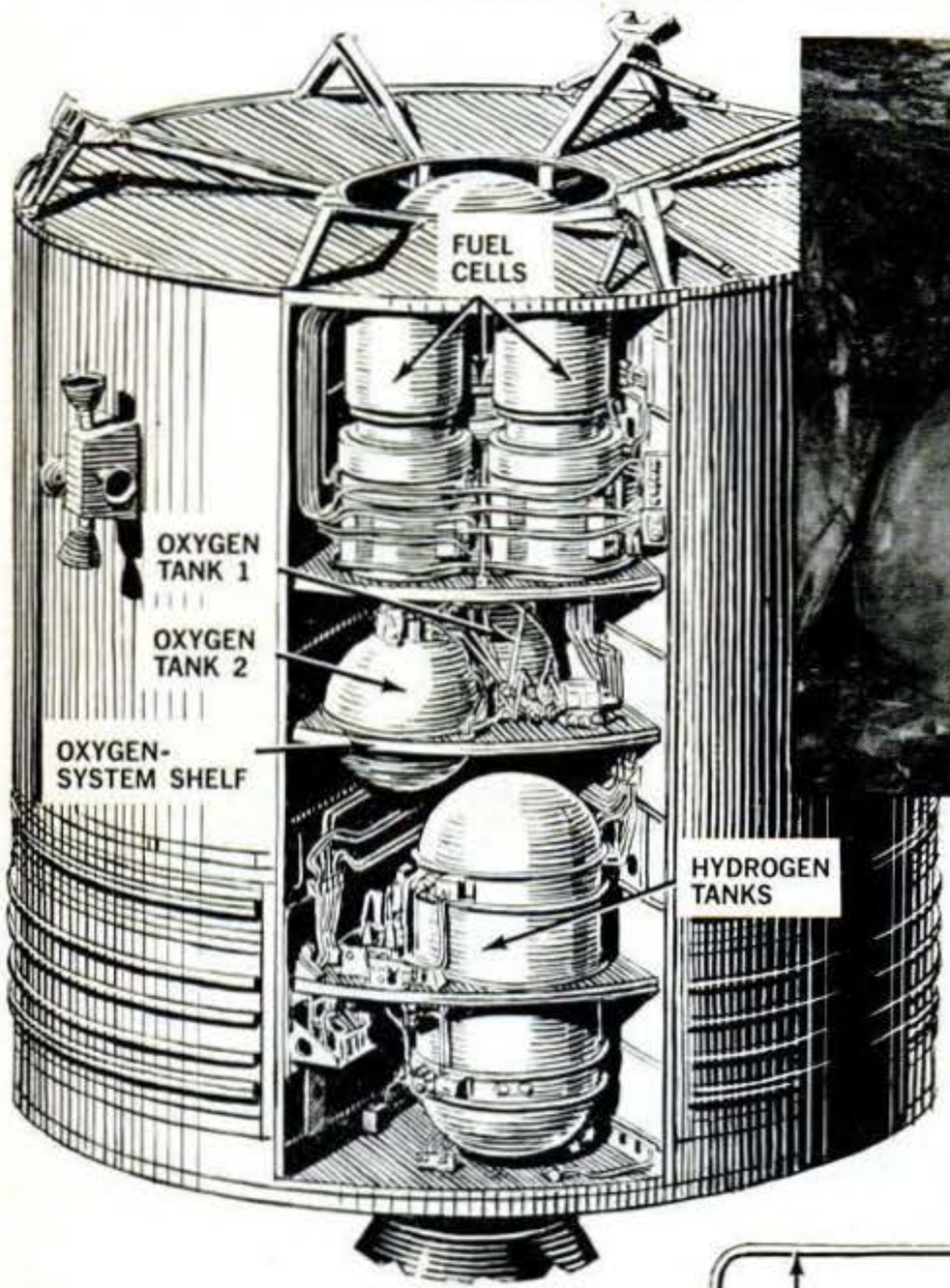
"Houston, we've had a problem. We've had a main bus undervolt."

The time: seven minutes, 53 seconds after 10 on the evening of Monday, April 13. Nobody knew it then, but the $375-million Apollo 13 moon-landing attempt had just aborted.

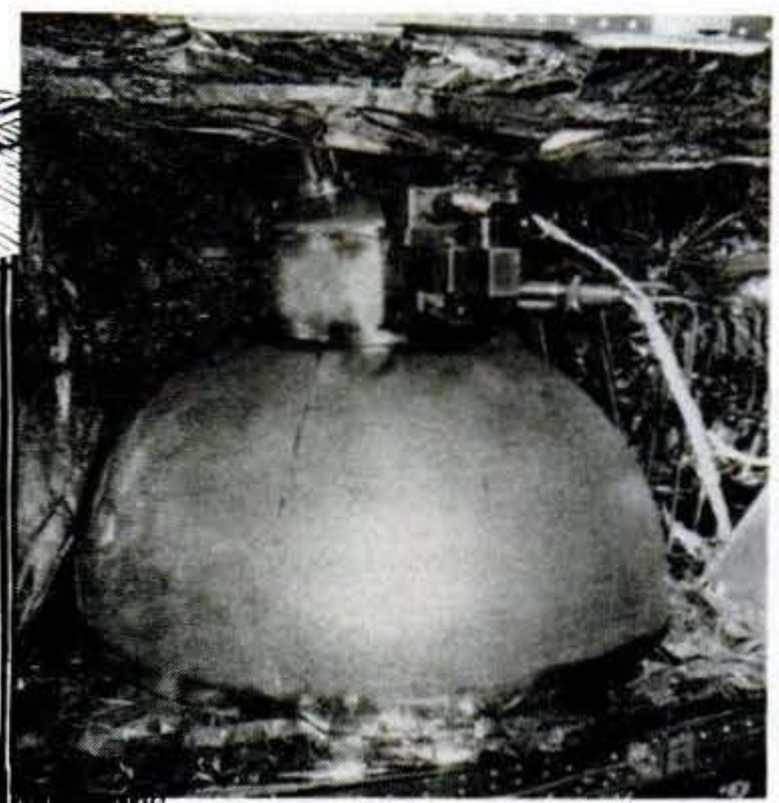
The astronauts heard a bang. Then, from the speaker at mission control, Commander Jim Lovell's voice: "It looks to me, looking out of the hatch, like we're venting something into space."

Within seconds, one of the two main oxygen tanks showed zero on the gauge. In three minutes, one of three fuel cells used to generate electricity was dead. Twenty minutes later, as astronauts and ground crews worked feverishly to try to find out what was wrong and do something about it, another fuel cell died. And the only remaining oxygen tank—No. 1—was losing pressure steadily, despite repeated attempts to save it.

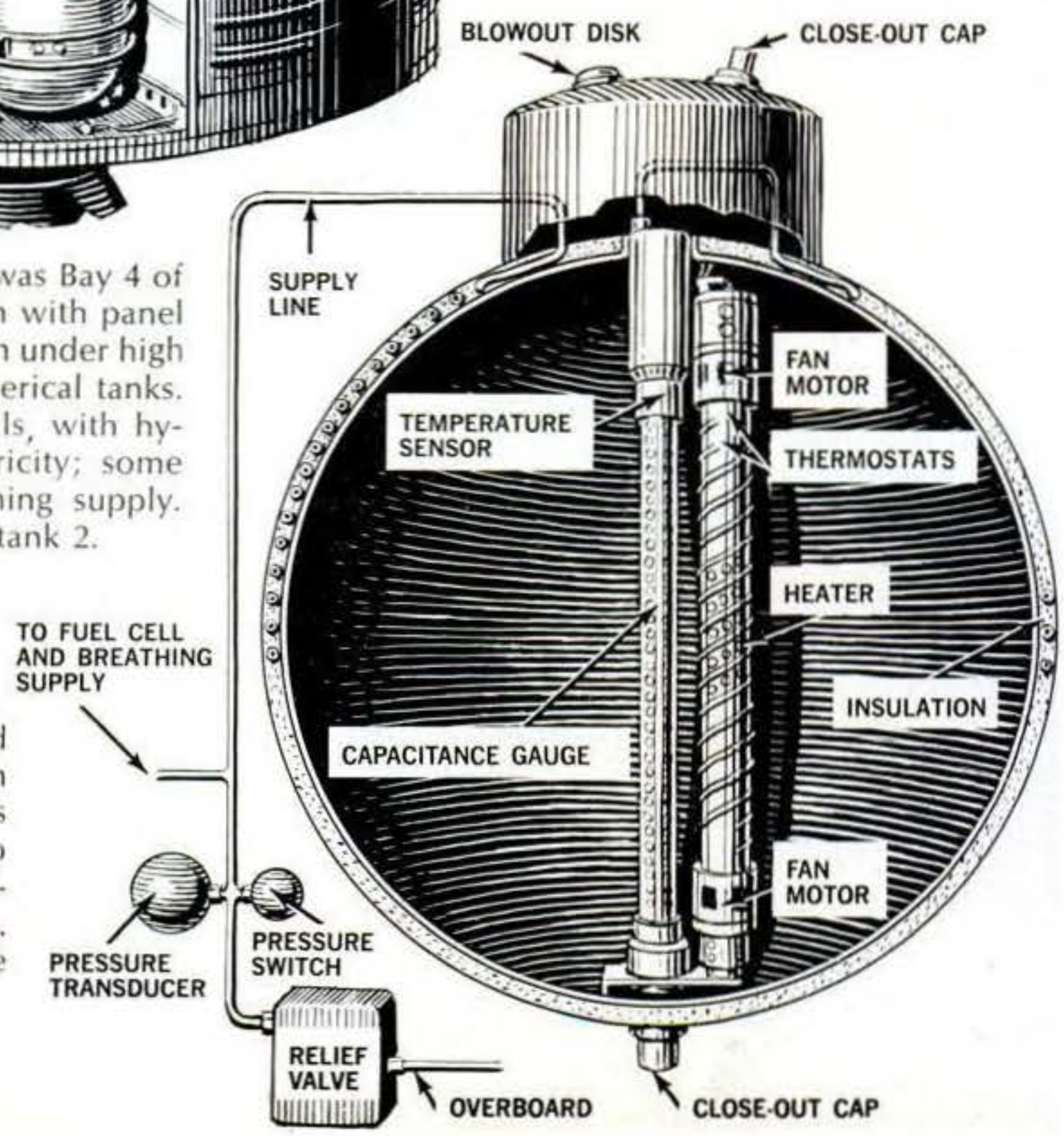
"It's slowly going down to zero," radioed Mission Control, "and we're starting to think about the LM lifeboat."



Site of near-fatal accident was Bay 4 of the service module, shown with panel removed. Supercold oxygen under high pressure was stored in spherical tanks. Most was to feed fuel cells, with hydrogen, to generate electricity; some was for astronauts' breathing supply. Explosion came in oxygen tank 2.

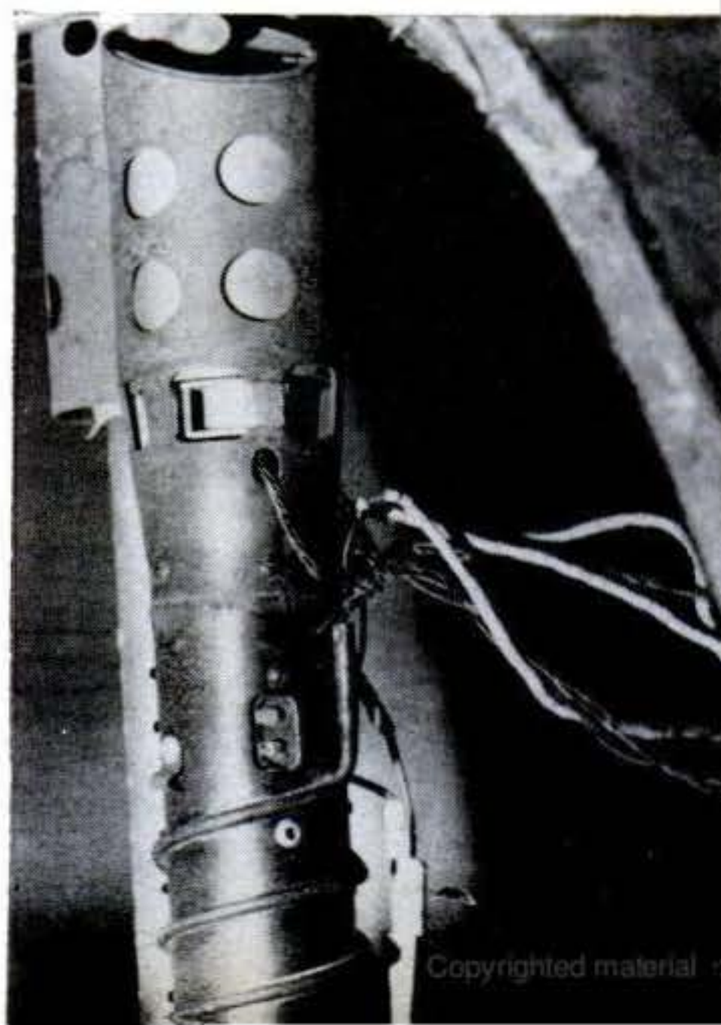


Burning wires ruptured conduit in dome atop oxygen tank 2 (above) letting oxygen escape. Shiny material is insulation.



Trouble started in fan and heater assembly of oxygen tank 2 (shown here in cross section). Fans were used to stir supercold oxygen, prevent it from stratifying. Heater was used to regulate pressure inside tank.

28-volt thermostatic switches were to limit temperature boost from the heater (shown close up). But during countdown tests on the launch pad, a make-do heating procedure for emptying the tank applied 65 volts to the switches.



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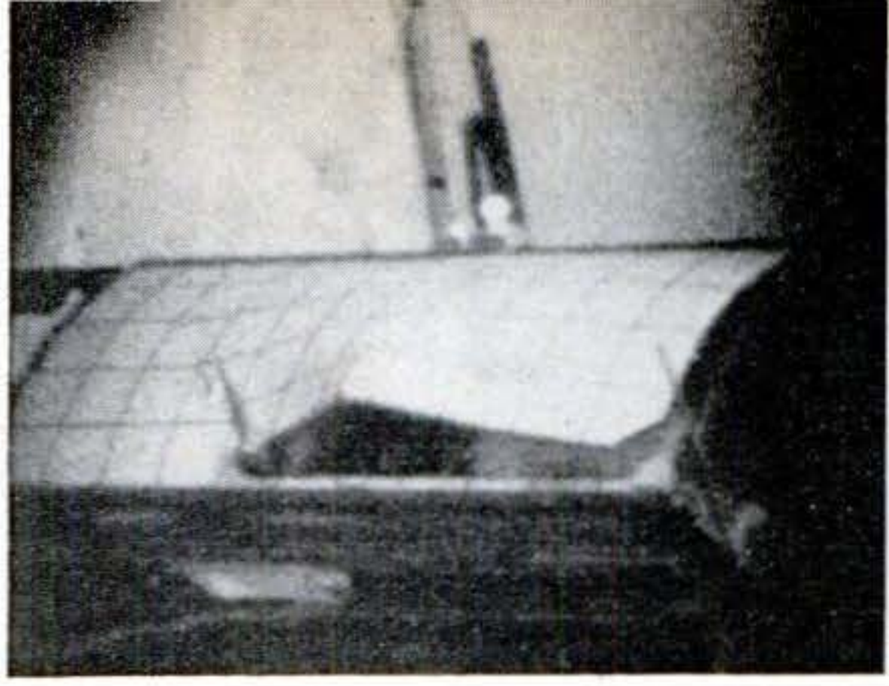


Accident is recreated using half-scale model of the service module's Bay 4 in a vacuum chamber. Sequence of explosion was captured by ultraslow-motion movie camera. First frame shows seam opening along side of panel. Next, panel is blasted into space.

"Yes, that's something we're thinking about, too," answered Lovell.

LM lifeboat. Space planners had thought about it before, but nobody really believed it would be necessary. Now the command and service module —the CSM—with its ample life-support supplies and electrical power reserves, its navigation and control systems, its complex radio and TV links with the ground, was as useless as a banjo without strings.

The lunar landing was off. Now it was a fight for survival. If the three men were to get home, they would have to depend on the cramped, spindle-legged LM and fly it across more than a quarter of a million miles of hostile space with the dead CSM in tow. But home was four days away. And the LM was meant only for a quick dash to the moon's surface.

The little moon lander and its crew made it. But even as the crippled ship tumbled slowly back to earth, the questions began: How could it have happened? The Apollo 13 craft was perhaps the most sophisticated machine ever conceived. It was designed, built, tested, and retested by some of the world's most talented engineers. It was identical to four other ships (two of which landed) that had flown to the moon. How could it, on this fifth trip, have suddenly blown up?

On the afternoon of Friday, April 17, Lovell, Haise, and Swigert splashed into the Pacific. The same day, NASA Director Thomas Paine launched the investigation. He appointed Edgar M. Cortright, director of NASA's Langley Research Center in Hampton, Va., to head the probe. Four days later, on Tuesday, April 21, Cortright and his panel of experts met in Houston and settled into a grueling 14-hour-a-day schedule.

Time bomb. Just under two months later, on Monday, June 15, the board announced it had the answer. Apollo 13, they said, carried a time bomb in its belly as it rose from Launch Pad 39A on that Saturday afternoon in early April. Not an actual bomb with dynamite and a ticking clock, but a fatal flaw that would explode with the same devastating effect.

Clues came from four sources:

1. *Pictures from space.* When the astronauts finally jettisoned the service module just before reentry, they took pictures of the damaged area.

2. *The crew's report.* What they had heard, seen, felt.

3. *Miles of telemetry tapes.* Second-by-second readings of voltages, currents, pressures, temperatures, quantities, flow rates all over the craft in the critical moments preceding and following the explosion.

4. *Detailed histories* of every nut, bolt, system, sub-system, and component of the space craft, from the moment each was made until it lifted off from Cape Kennedy.

From the beginning, the investigators found, suspicions led in one direction. At 10:05:58 on that fateful Monday night, Mission Control had asked the astronauts to turn on a set of fans in oxygen tank No. 2. They flipped the switch, and 16 seconds later, the pressure began to rise. Less than a minute and a half after that, the still-rising pressure suddenly plunged to zero. The crewmen heard the bang, saw something squirting out the side.

Charred spaghetti. In addition, the pictures from space showed that some violent event had blasted an entire panel from the side of the service module, leaving wires and parts trailing out like strands of charred spaghetti. The fuel-cell shelf, directly above the suspected tank, was tilted upward, as though broken from its moorings by a blast below.

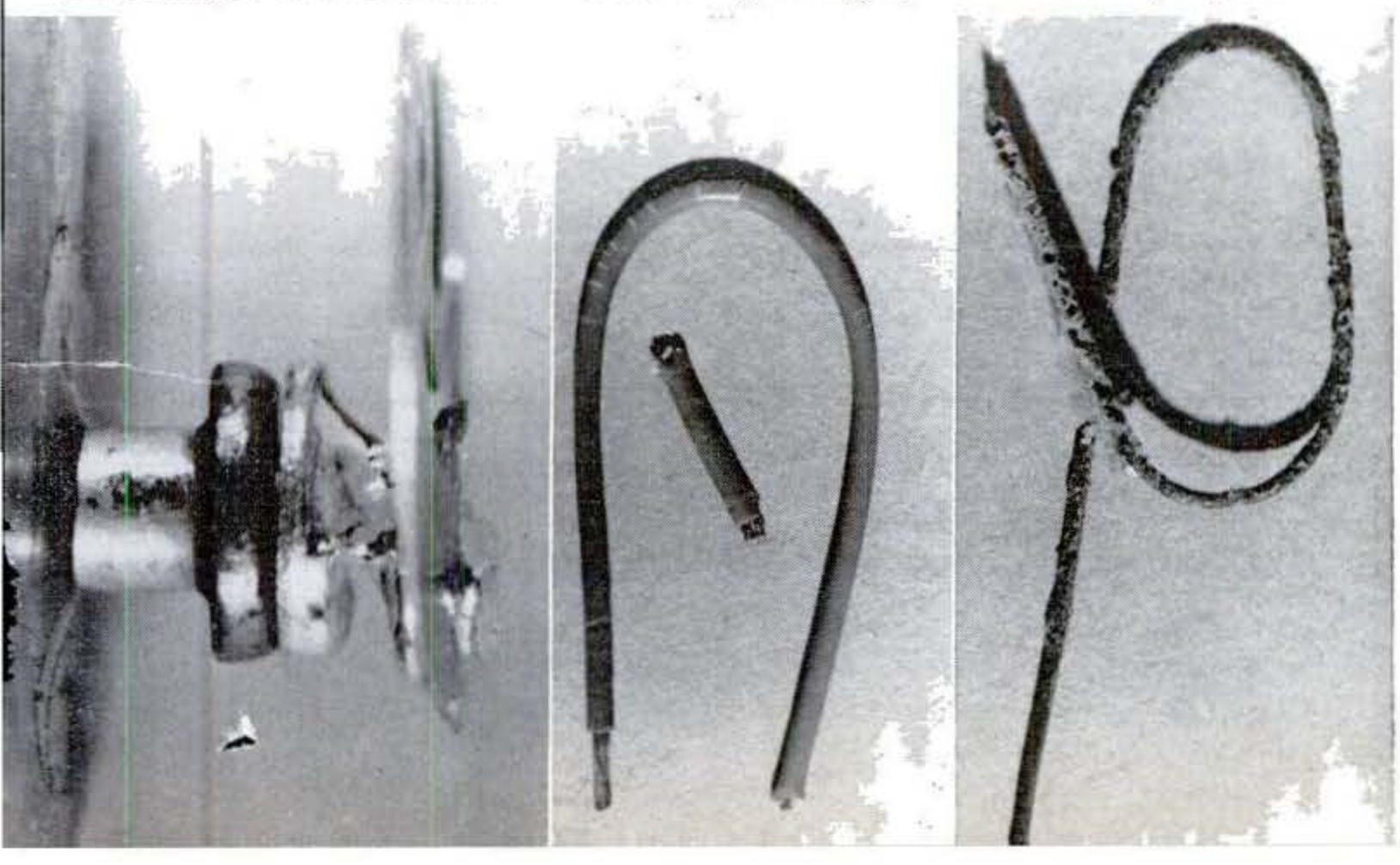
Theory: Oxygen tank No. 2 had exploded. The explosion had damaged a line or valve leading to oxygen tank No. 1, creating a leak and emptying it in about 90 minutes.

But what set off the explosion? And what should be done to eliminate the possibility of its happening again? Obviously, Apollo 14 could not fly until these questions had been answered.

The investigation began, logically, with the suspected tank itself. A team of investigators from Houston flew to the Beech Aircraft Plant in Boulder, Colo. Oxygen tank No. 10024XTA-0008 had begun life there in 1966. It was one of two tanks on Apollo 13, each designed to hold 320 pounds of supercritical oxygen—a dense, supercold (as low as −297°F) high-pressure (up to 935 pounds per square inch) homogeneous mixture that is neither liquid nor gas. Most of this

Thermostatic switches were welded shut (below) by overvoltage. Result: Heat in oxygen tank 2 zoomed to 600°F—1,000°F in spots while it was emptying. This damaged fan insulation.

Destruction of Teflon-insulated fan wiring was simulated by baking pieces of wire at temperatures encountered inside oxygen tank when thermostats failed. Left, effect of 752°F for one hour; right, 860°F for 30 minutes. Insulation cracks, chars, crumbles, then melts away, setting up electrical short, explosion.



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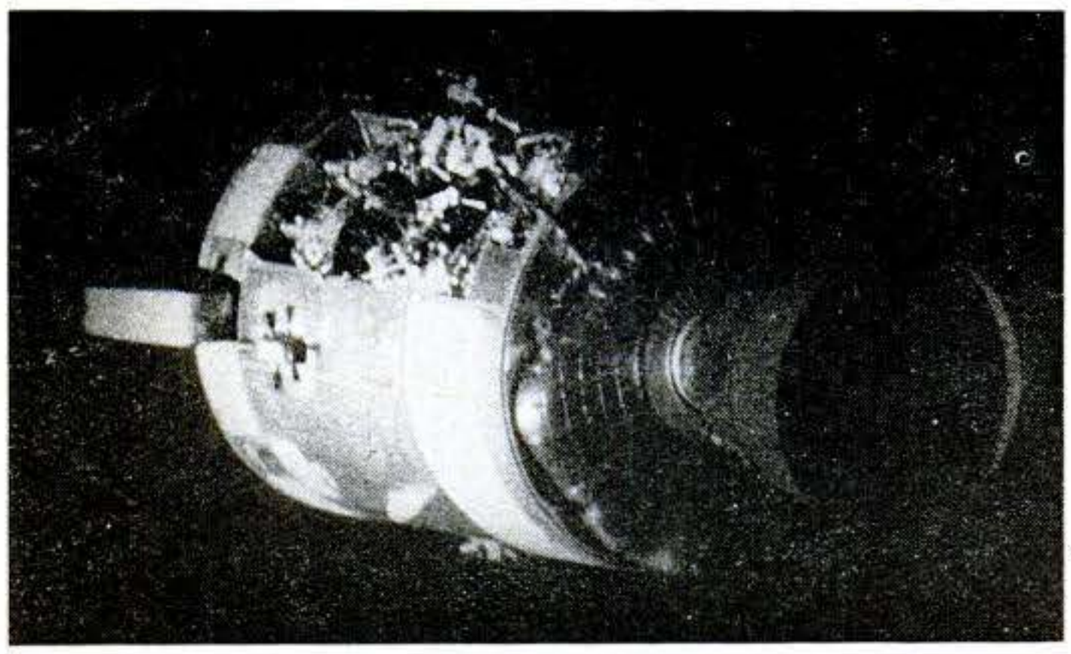

Goodbye, Apollo 13: Awesome view of crippled service module was taken from lunar module/command module after SM was jettisoned. Panel covering Bay 4 has been ripped off, exposing mangled equipment.

oxygen flows into the fuel cells, where it reacts with hydrogen in a process that generates electricity; some is used for breathing by the astronauts.

Supercritical oxygen can stratify—form separate layers of differing density—in the "zero gravity" of space. Stratification doesn't hurt anything, but it does make the quantity hard to measure. So designers put two fans in a tube and put the tube in the tank. When the fans are turned on, they suck oxygen in through holes in the middle and spew it out of both ends, thus stirring the contents of the tank.

The demand for oxygen is uneven. When the high-powered transmitter is sending live TV pictures back to earth and other systems are running, the spaceship can draw 100 amps from its fuel cells. At this level, the cells need a lot of oxygen. At other times, the demand may be a fourth that amount.

Keeping pressure constant. Designers had put electric heaters in the tank, coiled around the same tube that holds the fans. When the pressure drops, the heaters go on, and thus raise it. Two thermostatic switches were included to keep the heater temperature from rising too high.

After the accident, investigators checking over the design and manufacture of the tank found their first clue. The design called for assemblers to shove the wired fan and heater assembly inside, move it around, and fasten it in place without being able to look at it. If a bit of insulation were nicked or otherwise damaged, or a wire moved out of place, no one would be able to see it. Nevertheless, the completed tank had been put through extensive tests, found acceptable, and shipped off to North American Rockwell on May 3, 1967.

By early 1968, Rockwell had installed the tank on oxygen shelf 0632-AAG3277, tested it again, installed the shelf in SM (service module) 106, and tested some more.

Electrical interference showed up in a cryogenic pump, so engineers decided to remove the shelf and make some changes. They took out all of the bolts—except one. A special lifting jig slid under the shelf, raised the front about two inches, then broke when the overlooked bolt wouldn't let go. The shelf dropped back into place.

Okay for installation. Engineers calculated the force of the drop, decided it was too small to cause damage, tested and inspected the tank, and declared it okay. It was installed in SM 109 and shipped to Cape Kennedy in June 1969.

On March 16, 1970, countdown demonstration tests were begun to check out the Apollo 13 moon ship. Everything went well until technicians tried to empty oxygen tank No. 2 in the normal way—by pumping gaseous oxygen in through a vent tube and letting the supercritical oxygen come gushing back out of the fill tube. The tank refused to empty.

Engineers called on experts at Beech and North American Rockwell. They decided that there was probably a leak in an internal fill-tube fitting, so the gas they were pumping in was being short-circuited right back out. If so, it wouldn't affect the operation of the craft in space. Removing the tank and replacing it at this point would be a tremendous job, and might cause damage to surrounding parts. They decided to leave it in and use an unusual procedure to empty the tank—turning on the tank heaters and letting them slowly boil the oxygen out. It took eight hours.

Hello, astronauts: Lovell, Swigert, and Haise (rear) after successful splashdown.

All this past history was very interesting, but it didn't answer the question: Why did the tank explode? The space ship detectives decided to try a deductive tack.

Q. How could an explosion have been touched off?

A. An electrical fire in the tank.

Q. Where could fire have started?

A. In the wiring of the fans or heaters. A short circuit—an arc—might have touched it off.

The heaters were ruled out: They weren't on at the time. The fans, on the other hand, had just been turned on. And an examination of the telemetered voltages showed that there had been a voltage spike just after the switch was flipped. It was exactly the kind of spike that could be expected from a short.

Now it was beginning to fit. The sequence that ended in the fire could have gone like this: A wire had been nicked during the blind assembly process; it had shorted to ground during the flight; and the spark thus generated caused a fire.

But what could burn? Inside the tank were four materials: steel, aluminum, nickel wiring, and Teflon insulation—none of them noted for their flammability. Teflon is known best as the antistick lining in frying pans.

But the inside of a supercritical oxygen tank is no frying pan. In this cold, high-pressure brew, many normally nonflammable substances burn fiercely. Among them: Teflon and aluminum. The best candidate was the Teflon insulating the now suspected wires to the fan.

To test the theory, a team at the Manned Spacecraft Center in Houston built a steel cylinder, and installed a quartz window in one side so they could see in. They put Teflon-insulated wire inside, pumped the whole thing full of 900 psi supercritical oxygen, and touched off the Teflon with an igniter. "What we learned," says Edwin C. Kilgore, chairman of one of the investigating panels, "is that it's a lot easier to set off Teflon with a short circuit than we had expected." It burned rapidly, with a bright orange ball of flame traveling along the wire, consuming the insulation as it went.

The team was getting warm, but there were still a few details that didn't fit. The big one was detanking. Obviously, there had been something wrong. The internal [illegible] of the filler tube had probably been knocked out of place in the shelf-dropping incident. That's what had made emptying the tank difficult. But it didn't seem to be linked with the explosion.

The wrong smell. Maybe it was just coincidence—but it had the wrong

[*Continued on page 131*]

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Detroit's been listening to you!

8 EXCITING LITTLE CARS That Save You Money, Too

By **JAN P. NORBYE** / *PS Automotive Editor*
and **JIM DUNNE** / *PS Detroit Editor*

Little cars are *in* this year. They are news—and there isn't much to talk about in the '71 intermediates and full-size cars (except for wagons—see page 74). The reasons small cars are the talk of the town are not hard to find. Traffic congestion, continually getting worse, works in favor of small cars. They are easier to maneuver and park. Inflation has induced a switch to lower-priced, usually smaller, cars. And a growing population, with more families, is increasing multicar ownership—in most cases, adding one small car to the household. The chart below shows how America's car-buying habits have changed in only five years:

	PERCENT OF MARKET		CHANGE (PERCENT)
	1965 (12 mo.)	1970 (6 mo.)	
Sub-compacts	0	3.9	+3.9
Compacts	10.4	7.3	−3.1
Sporty compacts	7.0	7.5	+0.5
Intermediates	21.9	23.1	+1.2
Full-size cars	50.5	38.1	−12.4
Specialty cars	1.4	3.9	+2.5
Luxury cars	2.7	3.1	+0.4
Imports	6.1	13.1	+7.0
Total	100	100	

Don't be misled by the drop in compact sales. Compacts were down below five percent 18 months ago, but have bounced back. But the loss in popularity of the full-size cars has been gradual and steady, year after year. If you are interested in low first cost, low upkeep, and smaller gas bills, one of these eight thrift cars may be for you. They are built in America, for American conditions. They will cruise at 70 mph or better, yet give gas mileage comparable to that of imported cars. They're designed for Yankee-size people, and have many practical touches that Americans will appreciate. We call them "little" cars, because most Americans hang that label on anything smaller than an intermediate. Some are compacts, some sub-compacts, and three are mini-compacts—opening a new market that may jump to five percent next year! Prices for 1971 are still unannounced, but these eight cars span a range from about $1,845 to $2,250 (comparably equipped). Now let's look at them one by one.

A car doesn't have to be dull to be thrifty. The '71 economy models have great style and pep, and make a lot of sense all around. We've selected eight for our color gallery so you can start your shopping on the following pages

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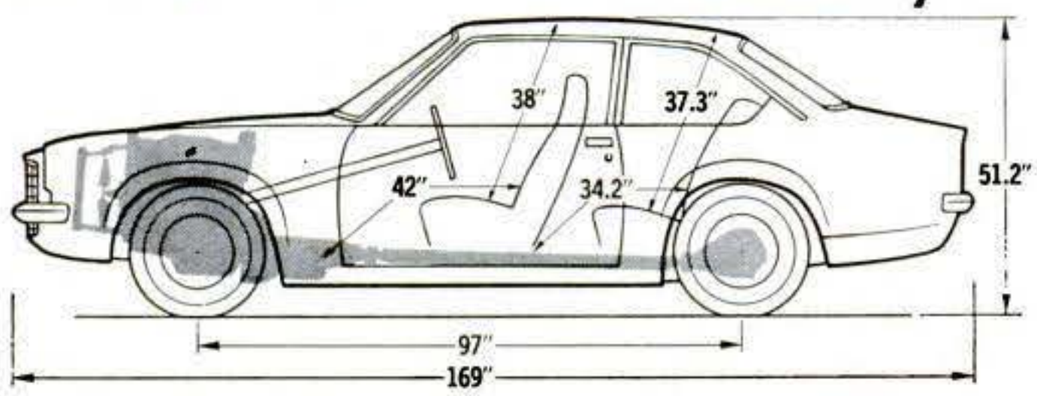
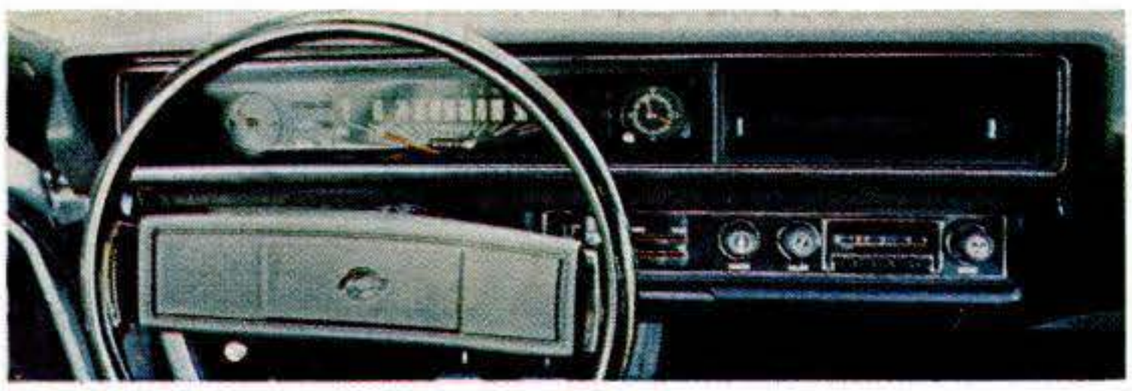
VEGA: Option-loaded four-seater from Chevy



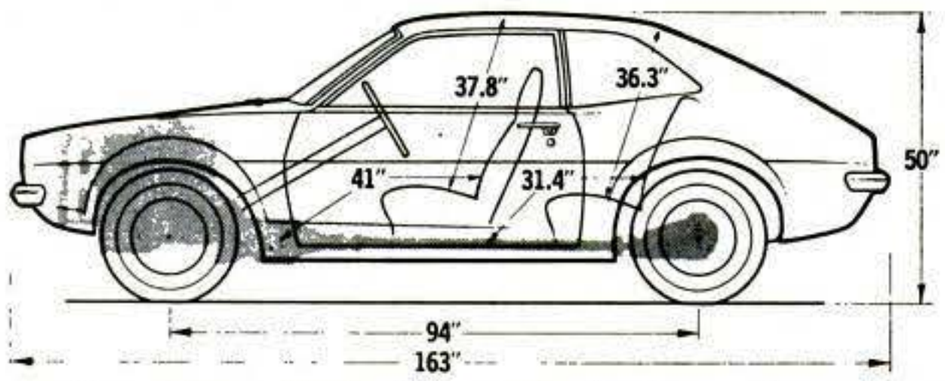
Basic Vega is a two-door sedan with ample seating space for four. Coupe (right) is optional. There's a wagon available, too.



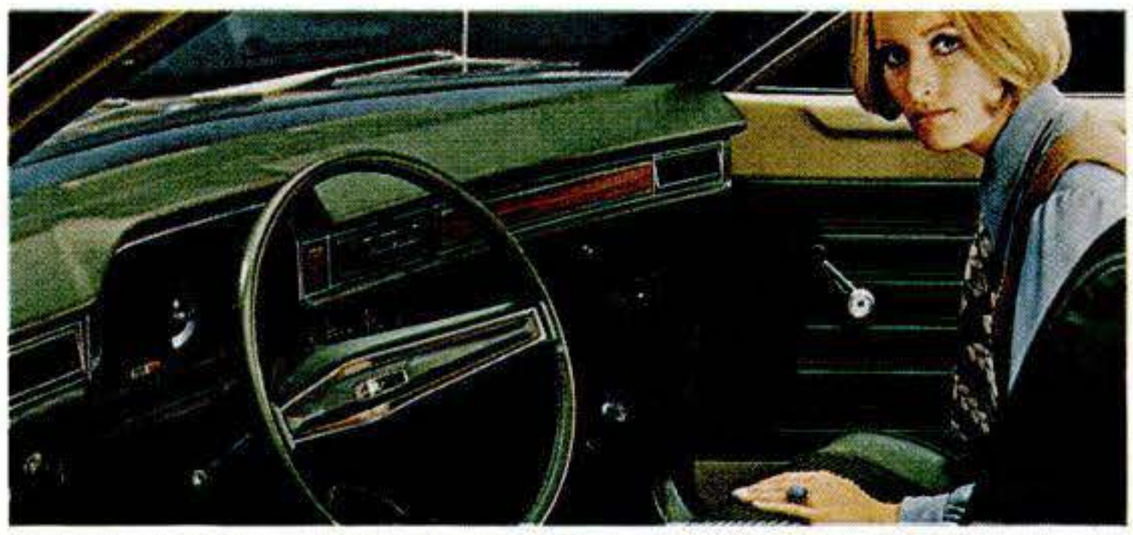
The instrument panel of the Vega is spartan (as is the Nova's), but all controls have been very conveniently positioned.

Chevrolet started with a clean sheet when designing the Vega. It has no parts in common with any other Chevy, and is assembled in an all-new super-automated plant. The chassis engineering bears the fruit of lessons learned with the Camaro, and at the wheel of the Vega you may think you're driving a smaller Camaro. Power? Plenty, with a 90-hp engine—and 110-hp optional. Both are single-overhead-camshaft four-cylinder units of 140-cu-in. displacement, differing mainly in camming and carburetion. Both will run on 91-octane gasoline. And

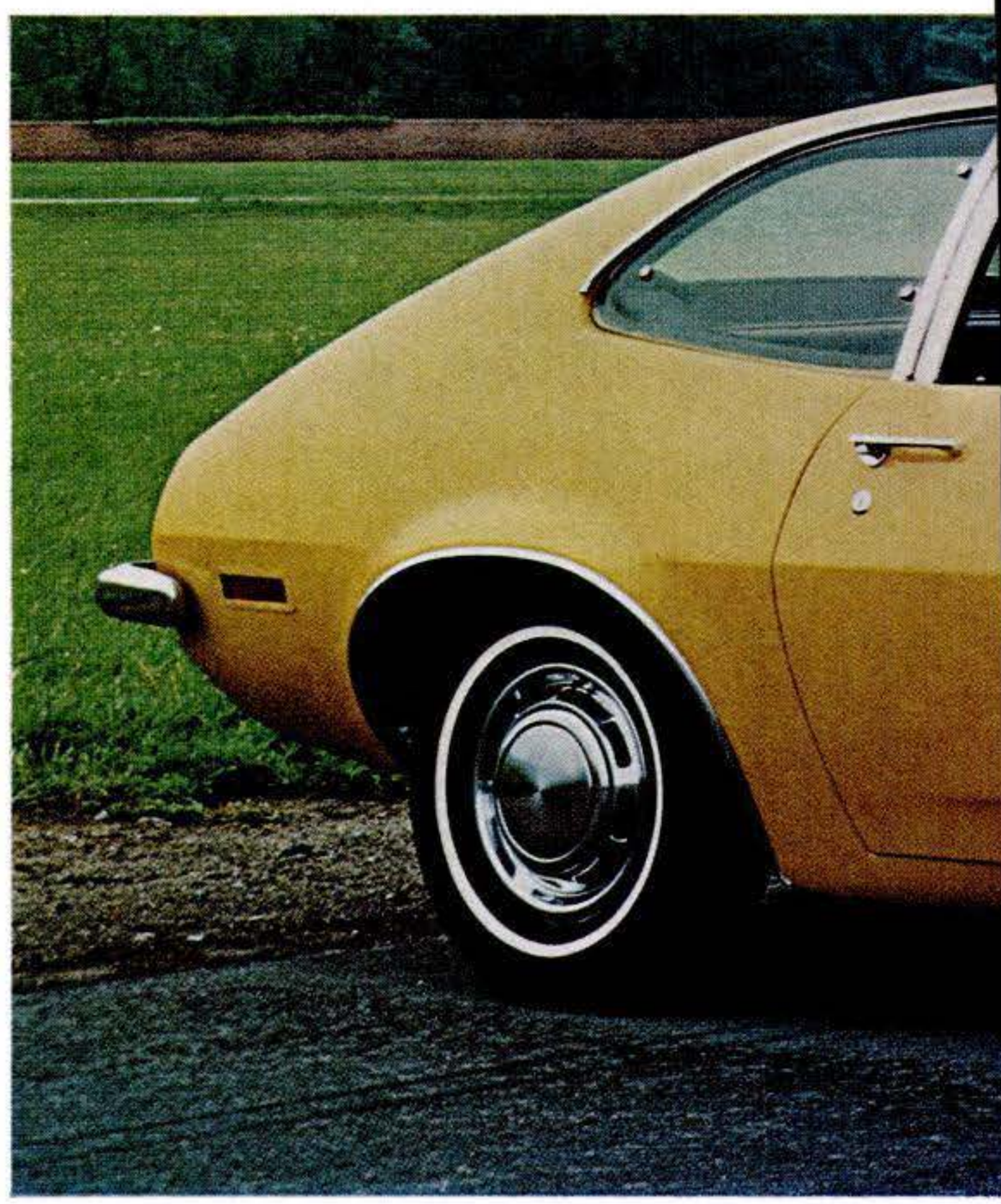
PINTO: Will it be Ford's Model T for the '70s?



It's small on the outside, big on the inside, with seating dimensions that are almost the same as those of the Maverick.



Instrumentation is simple and austere, but the Pinto's interior is bright and pleasant and makes the car feel bigger.



Ford plans to sell the Pinto for less money (probably as low as $1,845) than imported Fords such as the Cortina and Capri, which means it will collide head-on with the VW beetle in price as well as size. The Pinto is 4.3-inches longer, 7.7 inches lower. Low height gives a sleek silhouette, but it means that seats must also be very low to provide adequate head room. Pinto engines are imported—the standard 75-hp job comes from the English Cortina, and the optional 95-hp unit is produced in Germany for a new German-built model now on the way.

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factory-installed A/C is available with both engines. Like to shift? A three-speed manual is standard, a four-speed floorshift optional. The automatic options are Powerglide (two-speed) and Torque Drive (a Powerglide without the hydraulic control unit, giving manual shifts without use of a clutch). Optional axle ratios vary from 2.53 to 3.36 to one. The body style shown in the photo is the "hatchback" coupe. Front disk brakes are standard on all versions of the Vega. Prices will probably start around $1,925 for the base-model two-door sedan.

The optional engine is a single-overhead-camshaft type, while the Cortina uses pushrods and rocker arms. With both engines, four-on-the-floor is standard, and a fully automatic three-speed scaled-down Cruise-O-Matic is optional. Pinto has only one axle ratio regardless of power train: 3.55:1. As with the Vega, factory-installed A/C is optional. Rack-and-pinion steering gives great handling precision, and standard drum brakes are adequate for most purposes. Front disks are optional. Pinto will be produced in only one body style: two-door slant-back.

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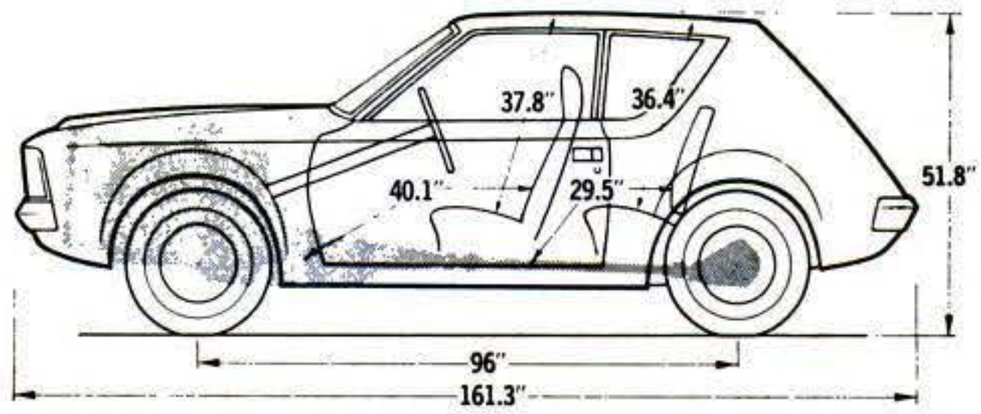
GREMLIN: Sawed-off Hornet for fun or business

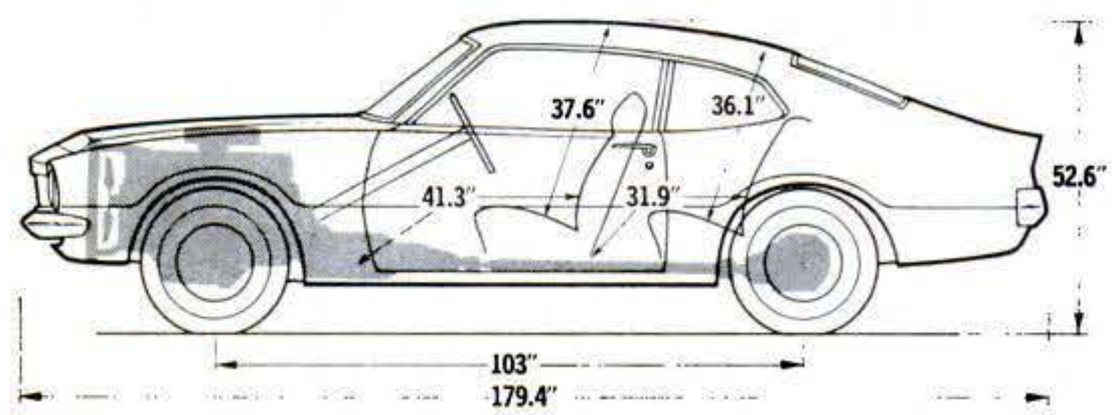
The two-door $1,950 sedan with the hinged rear window continues practically unchanged for '71, but the Gremlin's standard engine is no longer the 199-cu.-in. six. Now it's the 232-cu.-in. six, rated at 145 hp, that is standard in the Hornet and Matador. A new 258-cu.-in. six, rated at 160 hp, is optional. Both power units come with three-speed manual column shift or three-speed automatic; there is no four-speed floorshift option. Axle ratios are 3.08:1 (standard) and 3.31:1. Having the Hornet's front end, the Gremlin needs the optional variable-ratio power steering. Disk brakes are not available, but a Bendix power booster for the drum brakes is optional. The Gremlin's long hood takes up a large proportion of its overall length, eating into the useful space inside the car. The back seat, in fact, is optional. But the Gremlin is finding great demand as a runabout, with far more power than most cars of like size. Its striking appearance helped it exceed sales aims for '70; so—no styling changes.

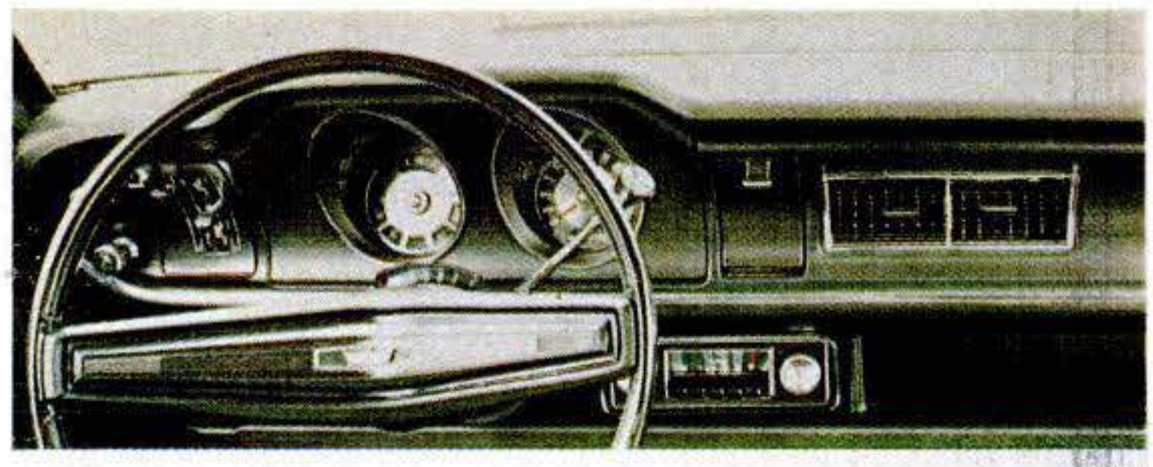


The Valiant-based two-door hardtop really seats five or six and comes to you with a number of desirable performance options.

MAVERICK: Between the Pinto and the Mustang

Ford's Maverick ranks alongside the original Falcon and the Mustang in instant public appeal. And now it's a better car than when first announced. Last winter an optional power-steering kit was smuggled into the production line. Floorshifts for the standard three-speed manual and the Cruise-O-Matic are available. There is a new 155-hp, 250-cu.-in. six. There's even a new four-door body on a stretched wheelbase. This new model makes a true family car of one that's also a popular favorite of young singles, nurses, teachers, and military men. But you still can't get a Maverick with a four-speed floorshift, disk brakes, or even power drum brakes. The base engine is the 105-hp, 170-cu.-in. six; and a 120-hp, 200-cu.-in. six is optional. There are no axle-ratio options; the standard ratio is 3.00:1. With the team of Pinto and Maverick, Ford feels confident that the Chevy Vega has been bracketed, and sees a continued rise in demand for the $1,995 Maverick.





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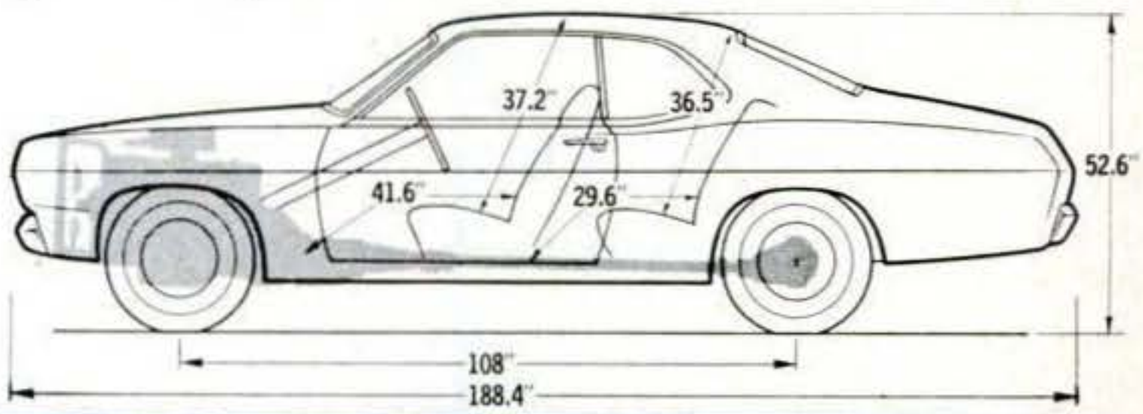
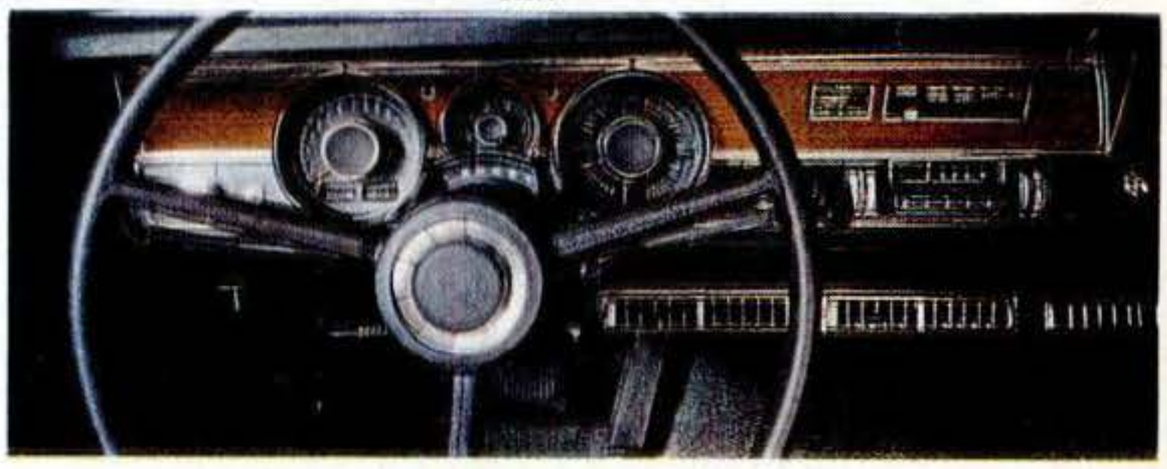
American Motors' stylists wisely refrained from tampering with striking looks of the successful mini-compact. A back seat is optional.

DUSTER: Plymouth's compact price leader

Last year, Plymouth's Duster was such a runaway success that Chrysler just couldn't make enough of them. It is the lowest-priced model (about $2,225) in the Plymouth line, yet it offers almost as much useful space as the Satellite intermediates. Because the Duster is light, the six-cylinder engines give it reasonable performance with great gas mileage. You have a choice between a 125-hp, 198-cu.-in. or a 145-hp, 225-cu.-in. six. Want power? There are optional 318- and 340-cu.in. V8s, but we feel that they take you out of the thrift-car field. Chrysler's all-synchro three-speed transmission is standard, and the excellent TorqueFlite automatic optional. Axle ratios are 2.76-, 3.23-, and 3.55:1. Power steering, power brakes, and front disk brakes are recommended options. As on all Chrysler products, an Airtemp factory-installed air conditioner is optional. There is only one Duster body style. If you want four doors, look into regular Valiant models, which have the same options.



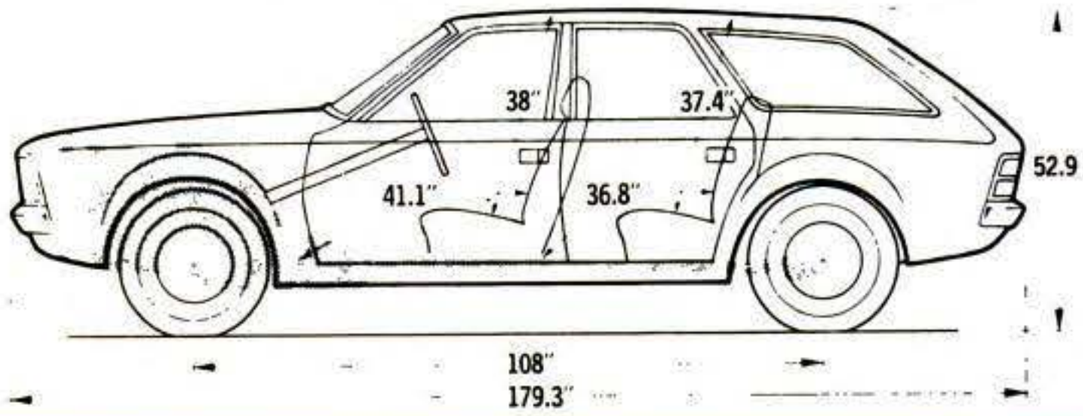


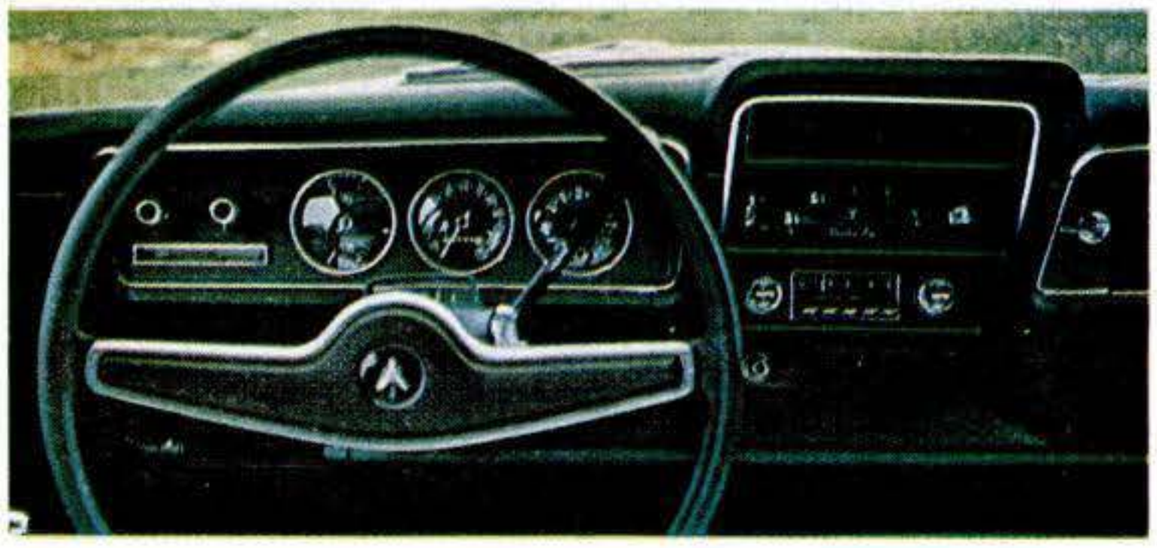
Ford's subcompact goes into second model year practically without alterations in its appearance, and the demand rises.

Dodge's counterpart to the Duster is called the Demon—a little imp that was spawned to effectively round out the '71 Dodge line.

SPORTABOUT:

Hornet five-door sedan is really a wagon



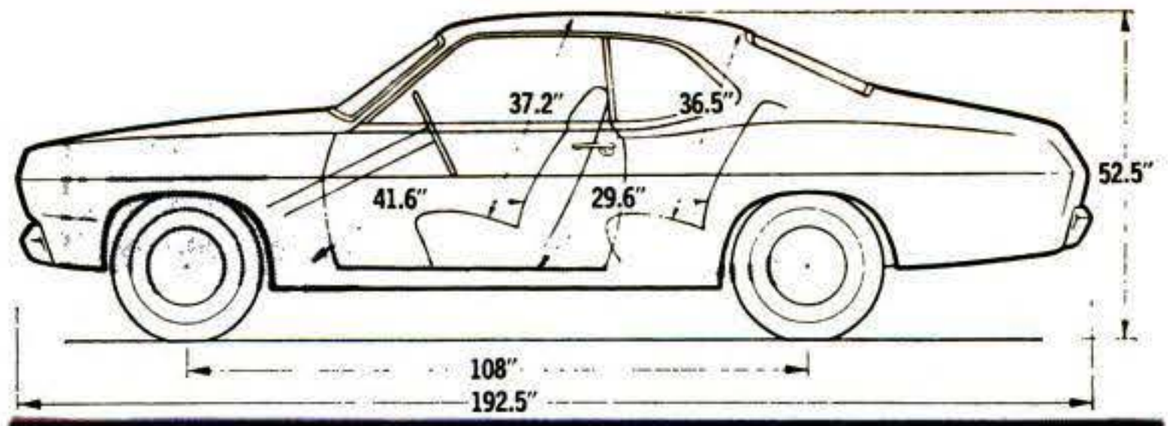


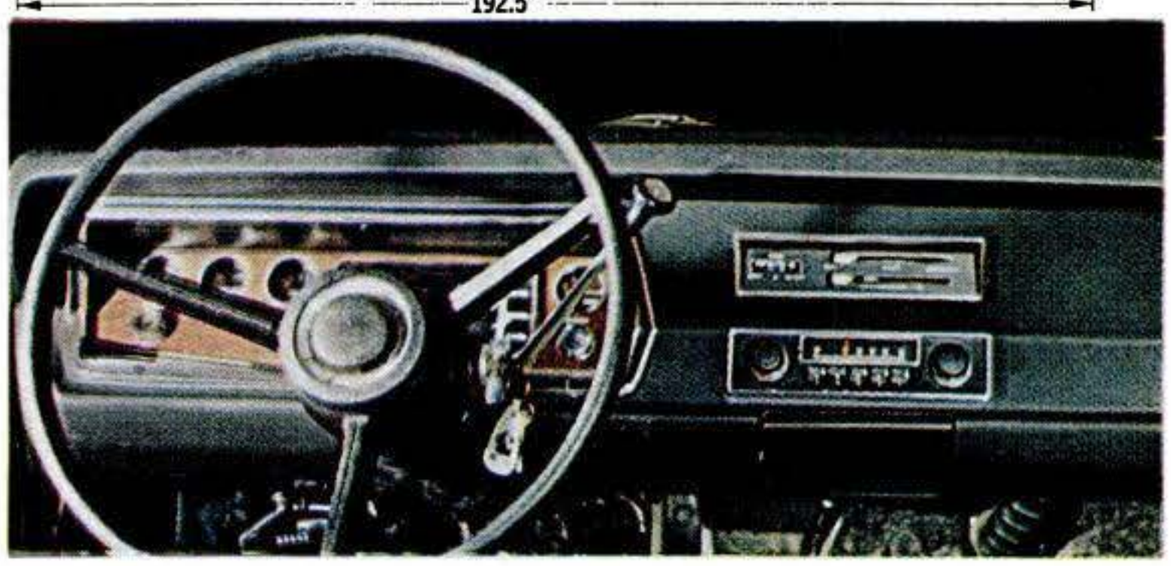
Using the Hornet running gear and underbody plus most of its sheet metal is a new car called the Sportabout, which combines the utility of a station wagon with the attractive appearance of a sedan. It is expected to sell at around $2,100. It's not an ordinary wagon, for the tailgate slopes at a very fast angle, almost matching the sharp rake of the windshield. The body is a four-door with folding back seat and reclining front seats. The standard engine is a 145-hp, 232-cu-in. six; also available is a new 160-hp, 258-cu.-in. six. The V8 option, an economical 304-cu.-in. job, does not move it outside the thrift-car field. A three-speed manual transmission is standard; a three-speed automatic, optional. There is no four-speed floorshift option. Variable-ratio steering is offered at extra cost. Front disk brakes are available only in combination with the V8 engine. Power brakes are offered for both drums and disks. Standard axle ratios are 3.08:1 with six-cylinder engines and 2.87:1 with the V8. Naturally, factory-installed A/C is available. With its wide stance, long wheelbase (in relation to overall length), wide-section tires, and generously dimensioned shock absorbers, the Sportabout combines soft springing and a pleasant ride with sure, safe handling and high-precision steering. For further facts on the Sportabout, see our '71 wagon story on page 74.

Basically a four-door Maverick on a stretched wheelbase, the new Comet will be available with V8 power options and automatic shift.

DEMON: Hot-looking Dart in disguise

This diabolical-sounding new Dodge was designed to offer the public a somewhat larger package for the same price as the competition's economy cars. Mechanically, it's a Dart, and the body is inspired by the sister model from Plymouth (Duster). Power options are a 225-cu.-in. six and 318- and 340-cu.-in. V8s. The standard engine is the 125-hp, 198-cu.-in. six. If you're serious about economy, stick with the sixes. They have an unequalled reputation for longevity and give adequate performance in compact cars. Transmission options vary from the manual three and four speeds to the TorqueFlite three-speed automatic. The $2,250 (approx.) Demon has only one body style. If you want a four-door sedan, look at the Darts.

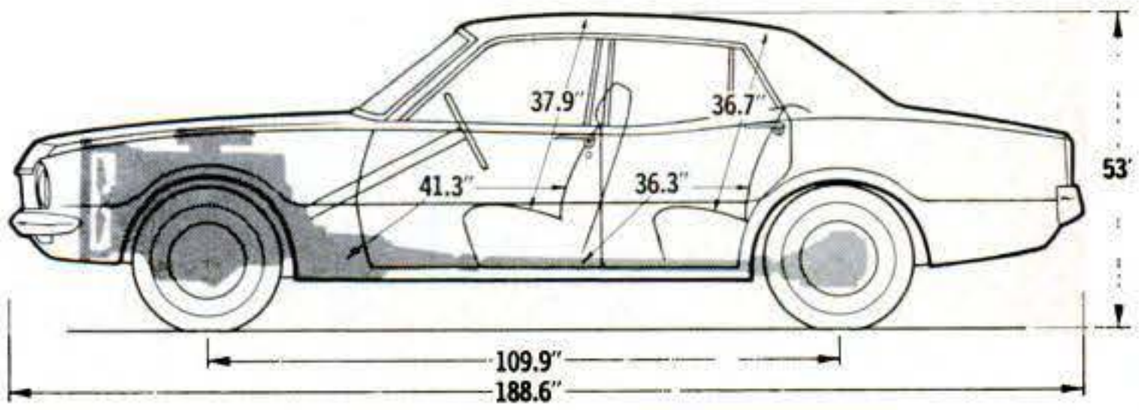


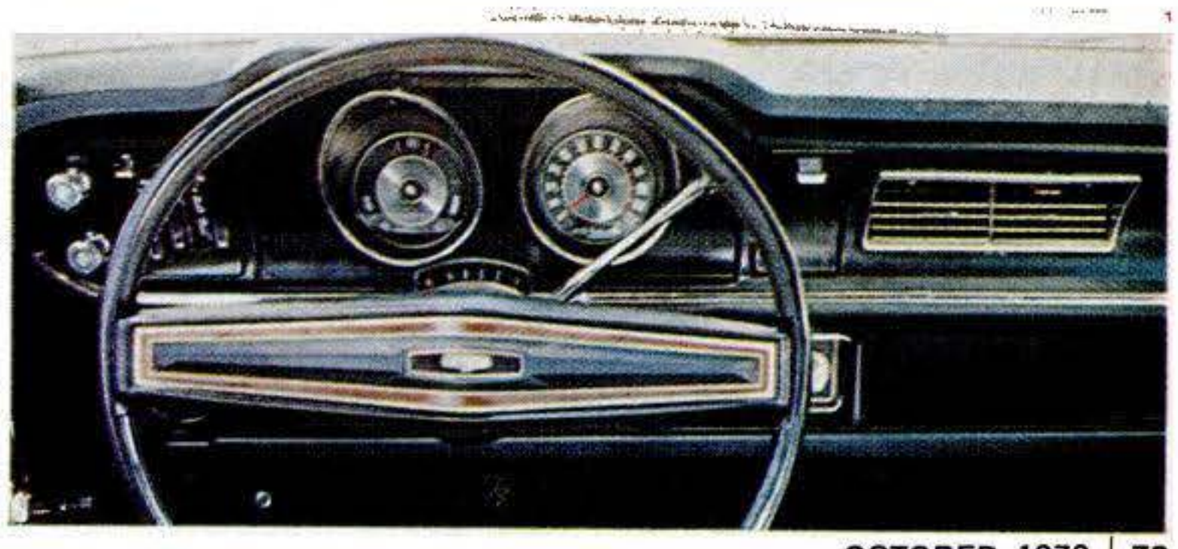


The elegant proportions and practical layout of the Sportabout are the chief attributes of this latest American Motors product.

COMET: Merc revives its shooting star

Almost equal to the 1960 Comet in interior dimensions, the new Comet is considerably lighter and offers a choice of power from a true economy 105-hp, 170-cu.-in. six to a 220-hp, 302-cu.-in. V8. The two-door Comet has a 103-inch wheelbase compared with 109.9 for the four-door version shown here. Standard transmission is a three-speed manual. The only transmission option is the three-speed Select-Shift automatic (no four-on-the-floor), but floorshifts are offered for both manual and automatic. Power steering is available (and recommended), but power brakes and disk brakes are not. Factory-installed air conditioning is expected to become a popular option. Basic price will be $100-$150 above Maverick. With both Comet and Capri, Merc looks strong in thrift-car field.





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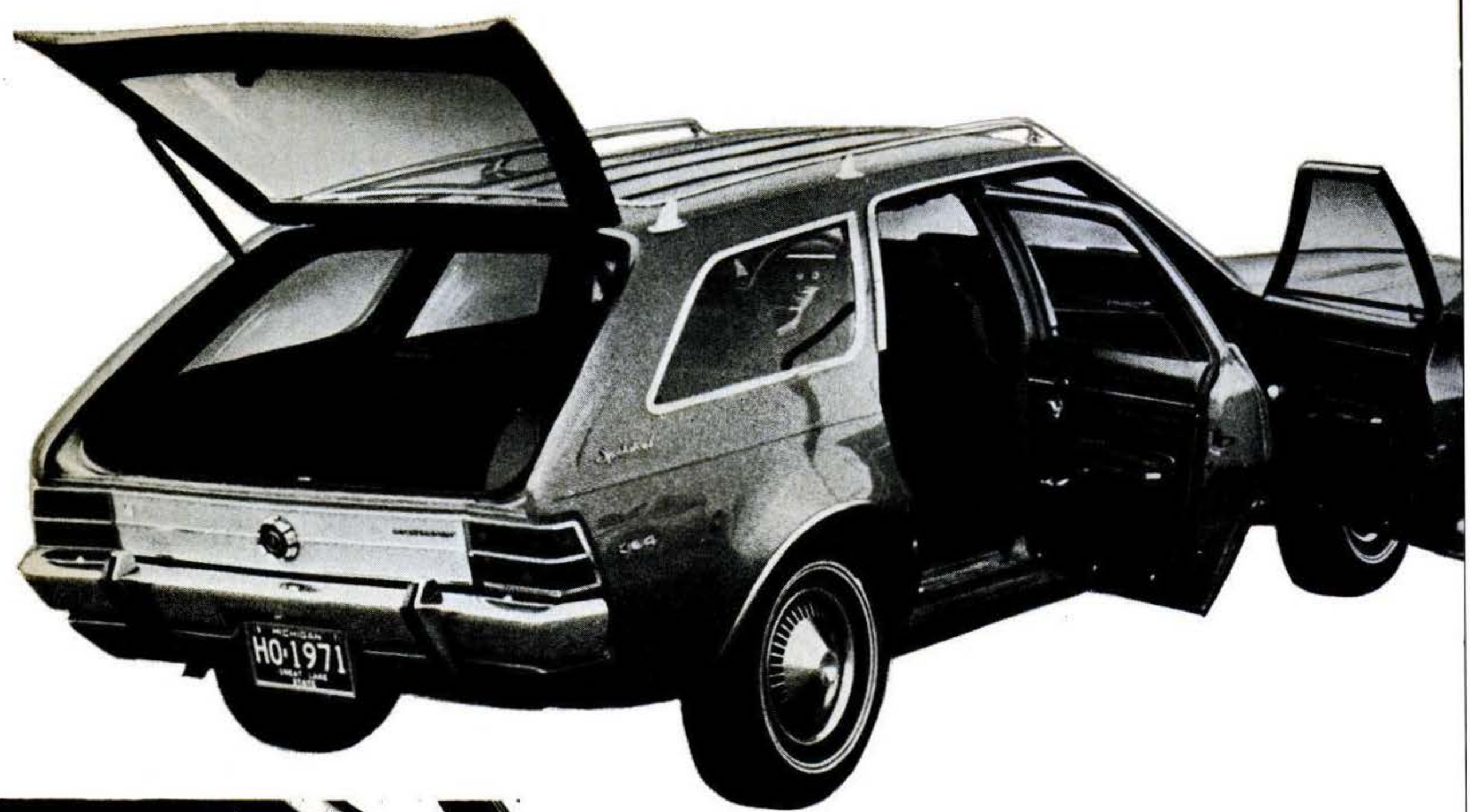
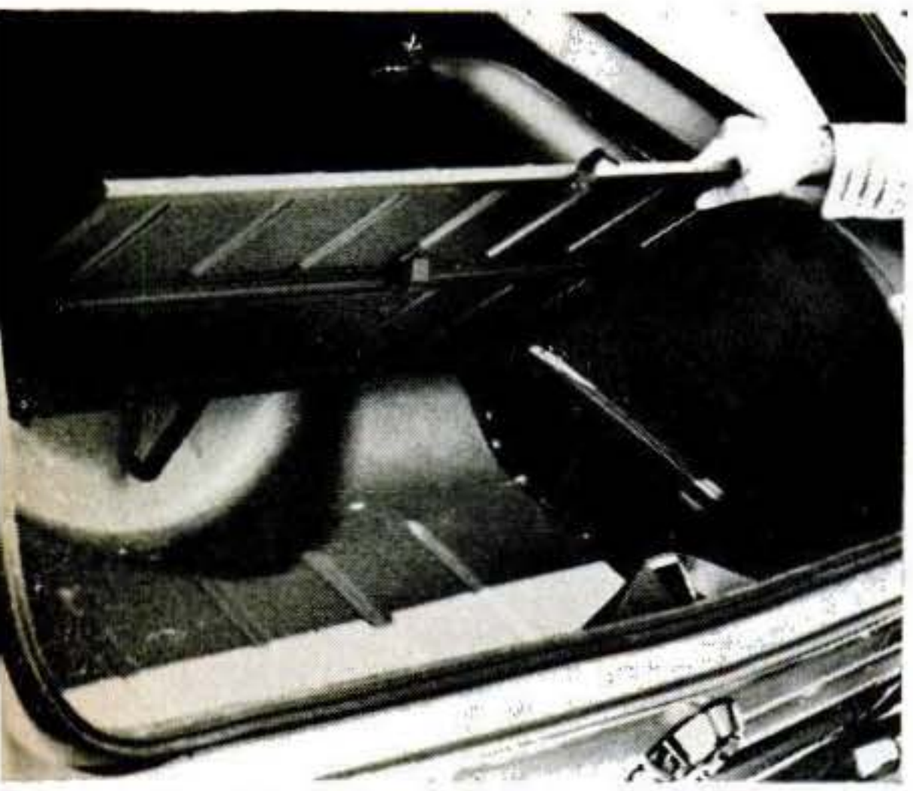




Sportabout by American Motors has a top-hinged tailgate, giving the same liftover height as the Hornet's. The cargo-area floor has a rear section that lifts up for access to the extra storage compartment.

The '71 WAGONS:

All-new small wagons are coming; while big ones get bigger and pack innovations

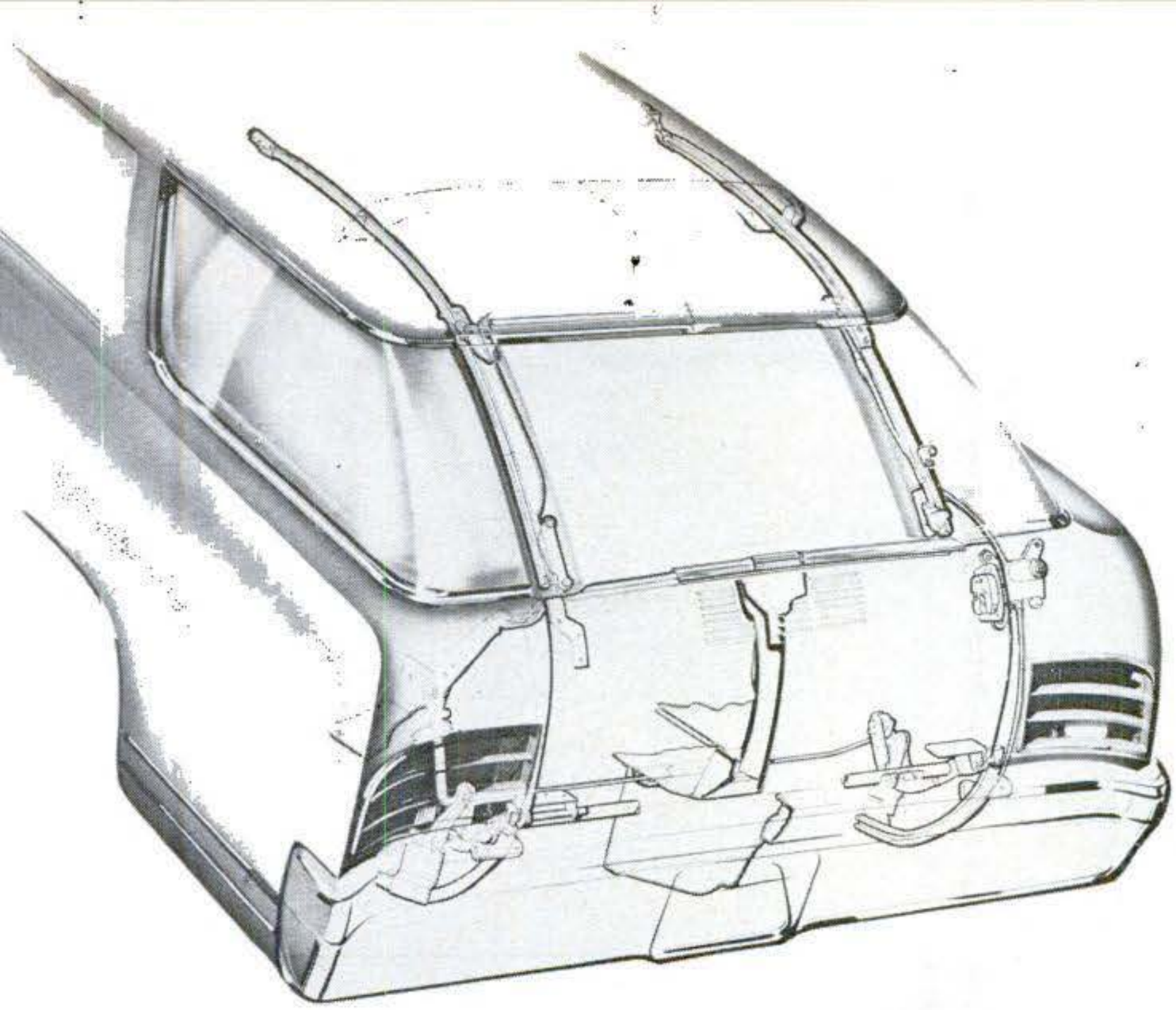
By **JAN P. NORBYE**
PS Automotive Editor
and JIM DUNNE
PS Detroit Editor

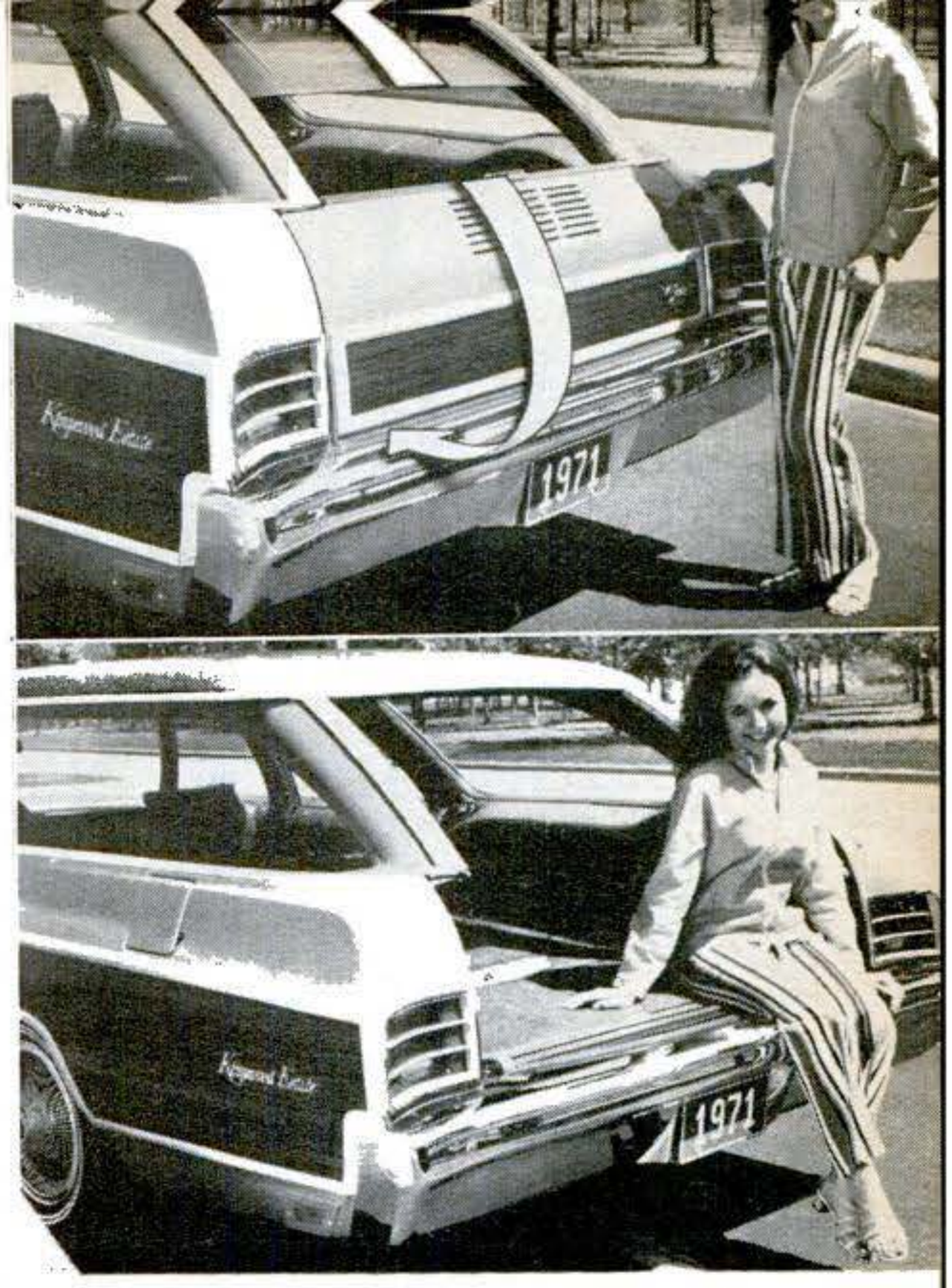
Good things are happening in the world of wagons. If you've been looking for a small wagon, you've been having a rough time. Chevy dropped the Nova wagon two years ago. The Falcon disappeared last winter. Dart and Valiant wagons went out three years ago, and the Rambler went when the Hornet came in. But suddenly it's 1971, and American Motors offers the smart new Sportabout (above) while Chevrolet has an even more compact wagon in the Vega line (below).

The Sportabout is based on the Hornet and has the same wheelbase and running gear. It also has the full versatility of a true wagon, without losing the good looks of the sedan.

The Vega wagon is a sensational little box on wheels, with unexpected

Vega wagon at the left shows true wagon versatility when compared with "hatchback" coupe version (center) and sedan at the right.





Check the construction drawing against photos at right to see how Glide-Away tailgate works on Chevrolet Kingswood Estate wagon.

Big Changes Coming Up

amounts of useful space. It has a storage area of 50.2 cubic feet! The oad platform is 67.4 inches long, 42.6 nches wide between the wheel housngs, and 47.4 inches wide at the belt ine. Maximum cargo height is 28.9 nches.

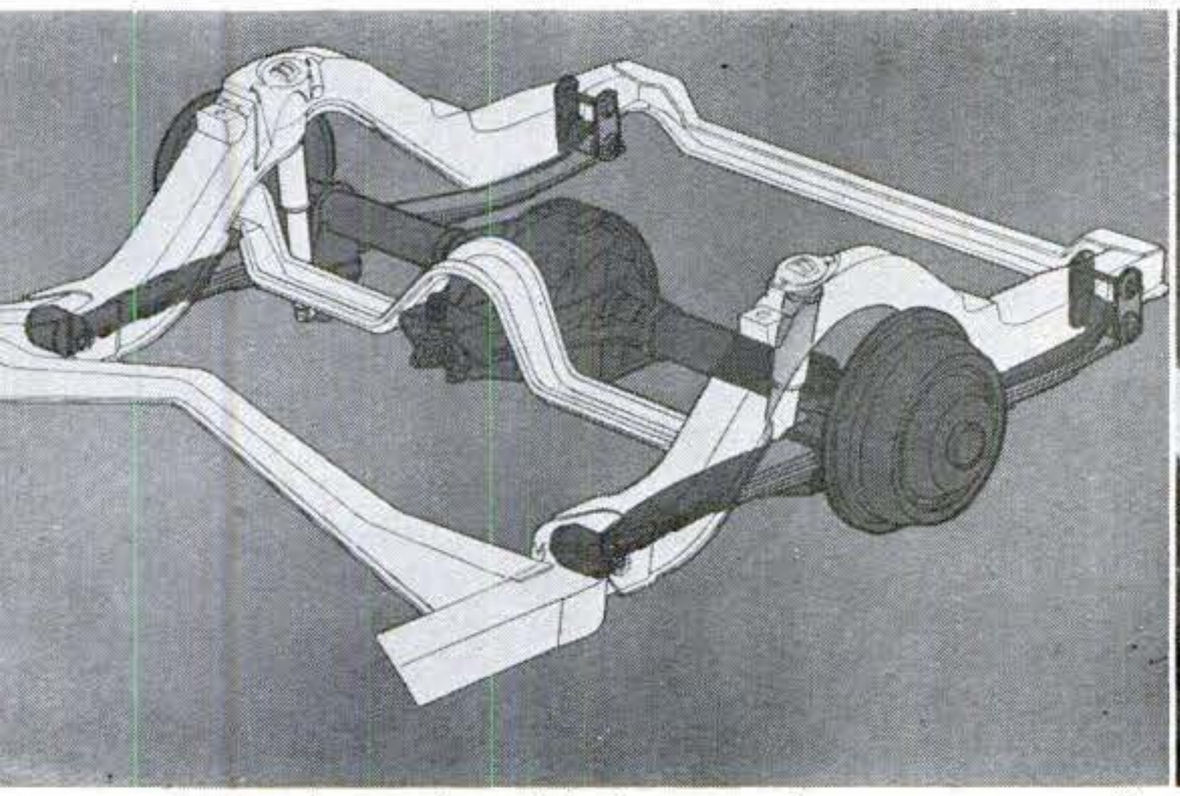
Good big-wagon news, too. Those big fellows from GM are bigger than ever—wheelbases of 125 inches for Chevy and 127 inches for Pontiac, Oldsmobile, and Buick. They're available with a forward-facing third seat—and what's more, they have a disappearing tailgate. The upper part of the tailgate—all glass—stops at the belt line. When opening, the glass tracks upward to rest horizontally inside the roof, while the lower part of the tailgate slides down to store inside the underbody, completely out of sight and out of the way.

Power operation of the glass is standard and there's a dash switch and an exterior switch on the rear panel. Lower tailgates are either manual or power-operated. The exterior switch for the manual tailgate has four positions: window down, lock, window up, and gate release.

A two-way lockout prevents tailgate release until the glass is raised eight inches or more, and keeps the glass from closing the last eight inches when the tailgate is down. The manual tailgate is counterbalanced (by a torque rod like that for balancing trunk lids), so that it drops part way, then needs about a 35-pound push to go all the way. Closing the gate calls for an upward pull of only four to five pounds on a center handhold in the top ledge.

The tailgate moves on nylon rollers in adjustable channels. The optional power gate can be operated only from the exterior switch (for obvious safety reasons).

What about cargo space in the new GM wagons? Up by about 10 cubic feet over the '70 models. PS



New rear suspension with multileaf springs for GM wagons (all full-size Chevy, Pontiac, Olds and Buick sedans have coil springs) saves space needed for the forward-facing third seat.

Norbye tries out the third seat in Pontiac's wagon. Access to this seat is provided when you tilt the right-hand section of the second seat, which is split in 40/60 proportion.

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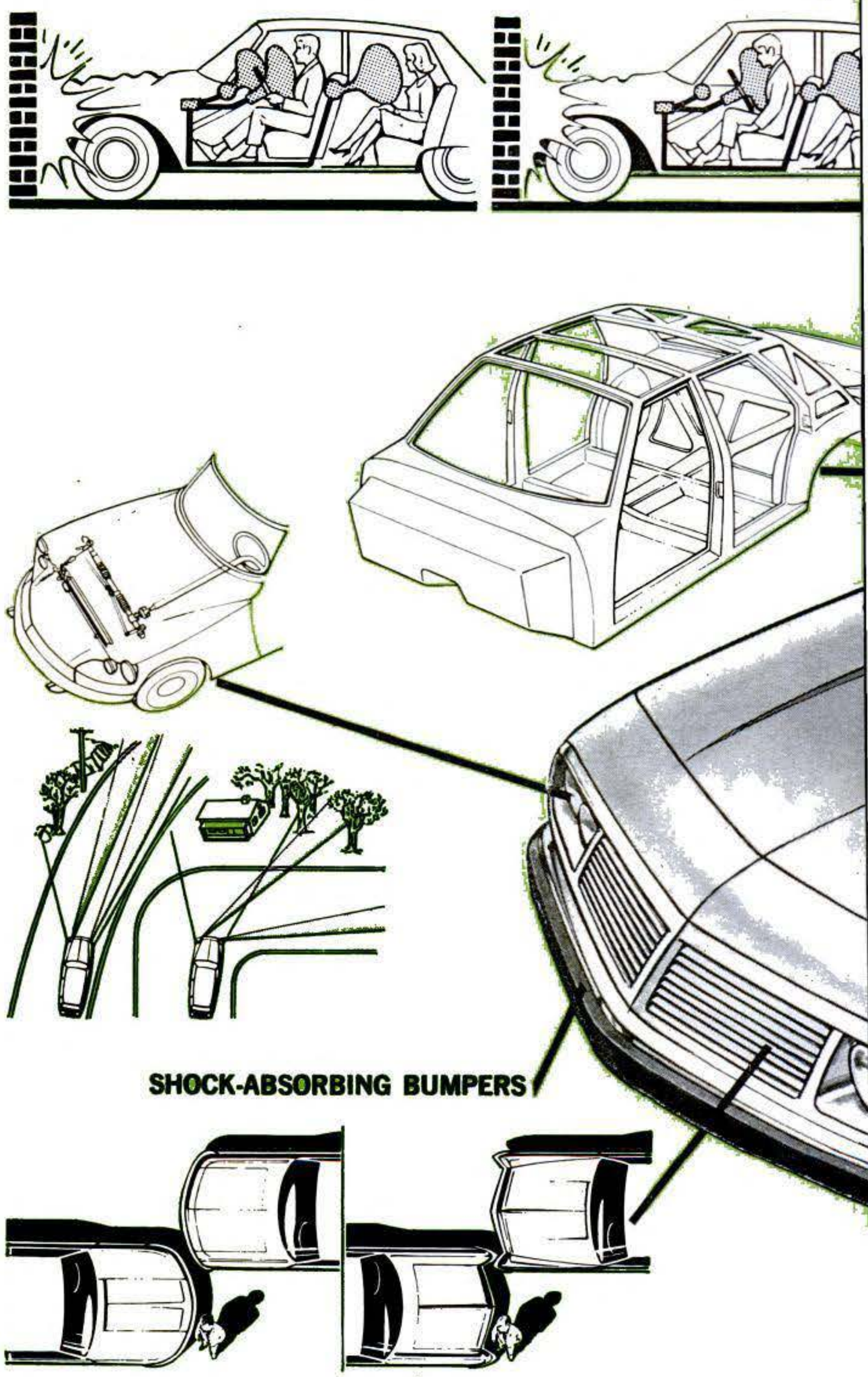
AUTO SAFETY:

we've come a long way, but there's still a long way to go

By **JAN P. NORBYE** / *Automotive Editor*
and **JIM DUNNE** / *Detroit Editor*



The 1971 cars show how far we've come in safety improvements—and how fast such improvements can be made. Most safety features that are now standard were only ideas five years ago.

Many appeared on cars because they were specified by federal government standards. These include lap and upper-torso belts for outside front-seat positions and lap belts for the other seats, head restraints, break-away inside rear-view mirrors and mandatory outside left mirrors, impact-absorbing steering columns, dual-circuit hydraulic brakes (with a warning light to indicate partial failure), and rupture- and leak-proof fuel tanks.

The auto industry, through its own research, has developed impact-absorbing frame and body structures that allow controlled collapse of the sections ahead of the cowl and behind the rear seat, thereby cushioning the shock of a collision impact while keeping the passenger compartment undeformed. All American cars use this principle, but some carry it further than others. General Motors was first to recognize that not all collisions are frontal, and developed the side-guard beams that are now part of the armor inside the doors on practically all models. Similar designs were later developed by the other auto makers.

The industry has also pioneered antiskid brakes. Ford uses a rear-wheel-only system developed in collaboration with Kelsey-Hayes on Thunderbirds and Lincolns. GM has a Delco-Moraine two-wheel system for its front-drive cars, Toronado and Eldorado. And Chrysler now offers a four-wheel Bendix system on the Imperial.

Other accident-preventive safety features include disk brakes, belted tires, variable-ratio power steering, door handles that preclude unintentional opening, and larger window areas for improved visibility. The Department of Transportation has specified a certain amount of standardization, such as the PRNDL sequence for automatic transmissions, but no rules are yet laid down for the exact positioning of such items as headlight and wiper/washer switches, horns, or other small controls.

The air-bag problem. The car shown here is a composite of safety developments under investigation by the industry or government agencies, or actually in use on certain cars built outside the U.S. Some of these developments could be adapted to Detroit cars in normal lead time, while others offer problems that must be solved before production can begin. One case in point is the air bag (passive restraint system). The bags may inflate quickly enough to save lives in collisions, but they tend to blow out the windows, could cause injury to passengers in awkward positions as well as to pipe-smokers, and would probably kill a child standing up in the car.

Belts and upper-torso restraints give better rollover protection than present-day air bags, but the drawback with belts is that they require the driver and passengers to do something. Air bags inflate on order from a sensor that knows the car is in an accident, and require nothing of the occupants.

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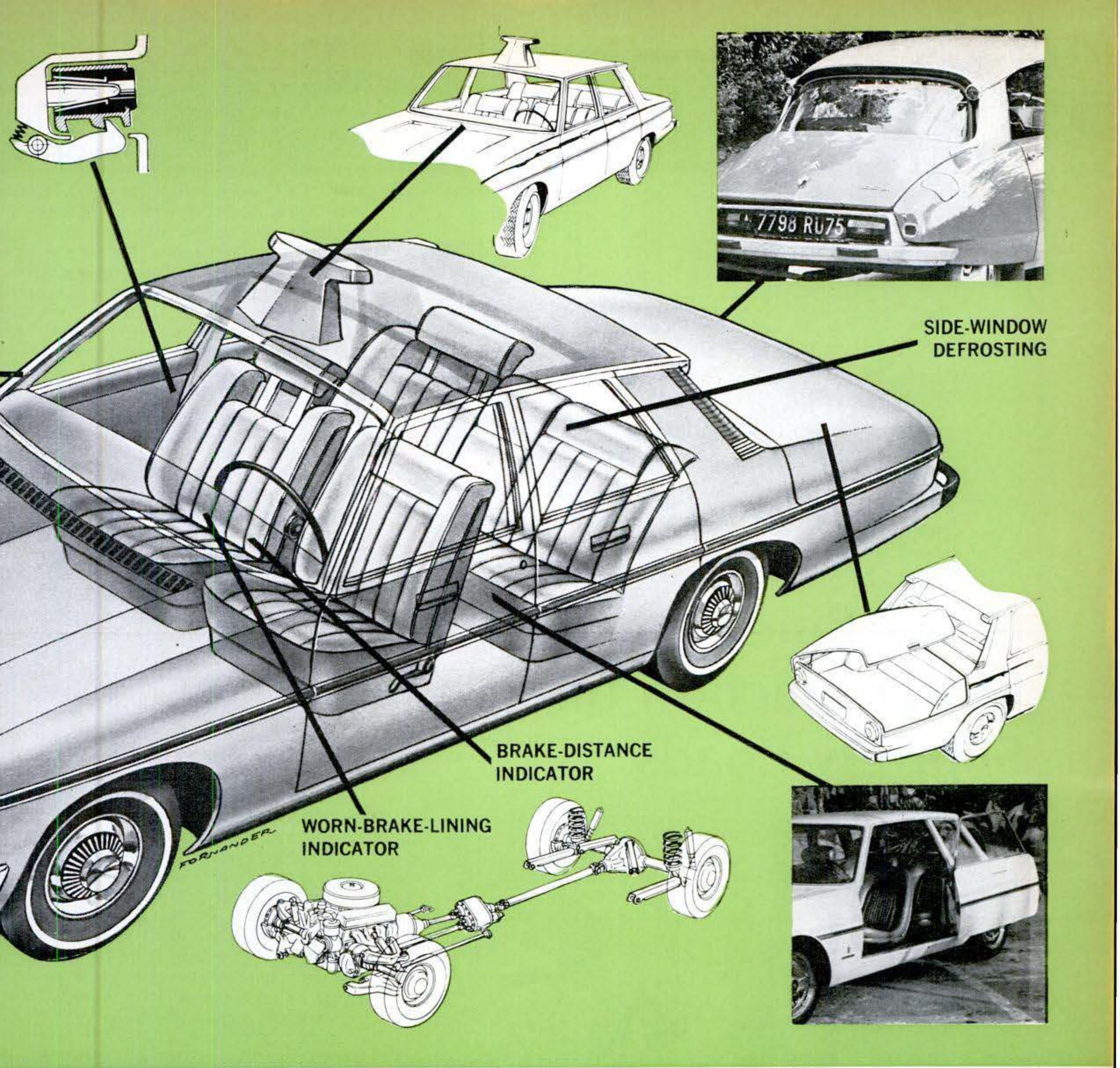

Rollover accidents may be rare, but don't forget that some head-on collisions end in a rollover. For such cases there must be survival space inside the car. The roof must not cave in, the "greenhouse" must not collapse. A form of roll cage, to be incorporated into the basic body shell, is a probable solution.

Doors must remain closed. They are needed not only to keep the occupants from being ejected, but also to contribute stiffness and strength to the body structure. Bolt-type door locks, such as used by Mercedes-Benz, have proved effective in keeping the doors closed in all types of accidents.

Bumper shape can help reduce the severity of a collision. With rounded bumpers, cars may bounce off each other, while W-bumpers will almost invariably make matters worse. That applies to vehicle-pedestrian collisions, too.

Other ideas that will protect users of a vehicle when it is standing still are sliding doors and side-opening trunks. Standing on the sidewalk instead of behind the car to load or unload the trunk, a man is in less danger of being hit by another vehicle. Sliding doors keep other vehicles (or even pedestrians) from running into a barrier formed by a suddenly opened door.

To see and be seen. Visibility is a key word in all auto-safety talks. That means both seeing and being seen. The periscope-type rear-view mirror suggested by the designers of the New York State safety car would certainly give drivers a more complete view than any mirror combination now in use. The high-level turn signals used by Citroën are easily seen, from almost any angle. It may be a good idea to move all taillights up to eye level. Steered and self-leveling headlights are standard on Citroën cars sold in France. While this system is now *outlawed* in some states, it may one day be *required* by the Federal government.

Finally, a word about four-wheel drive. An advanced system with a central differential would enable unskilled drivers to maintain safe and sure control of their cars in rain, snow, and ice, and chances are they would be willing to pay the price. The drawing above shows the Ferguson system, standard on the Jensen FF car. PS

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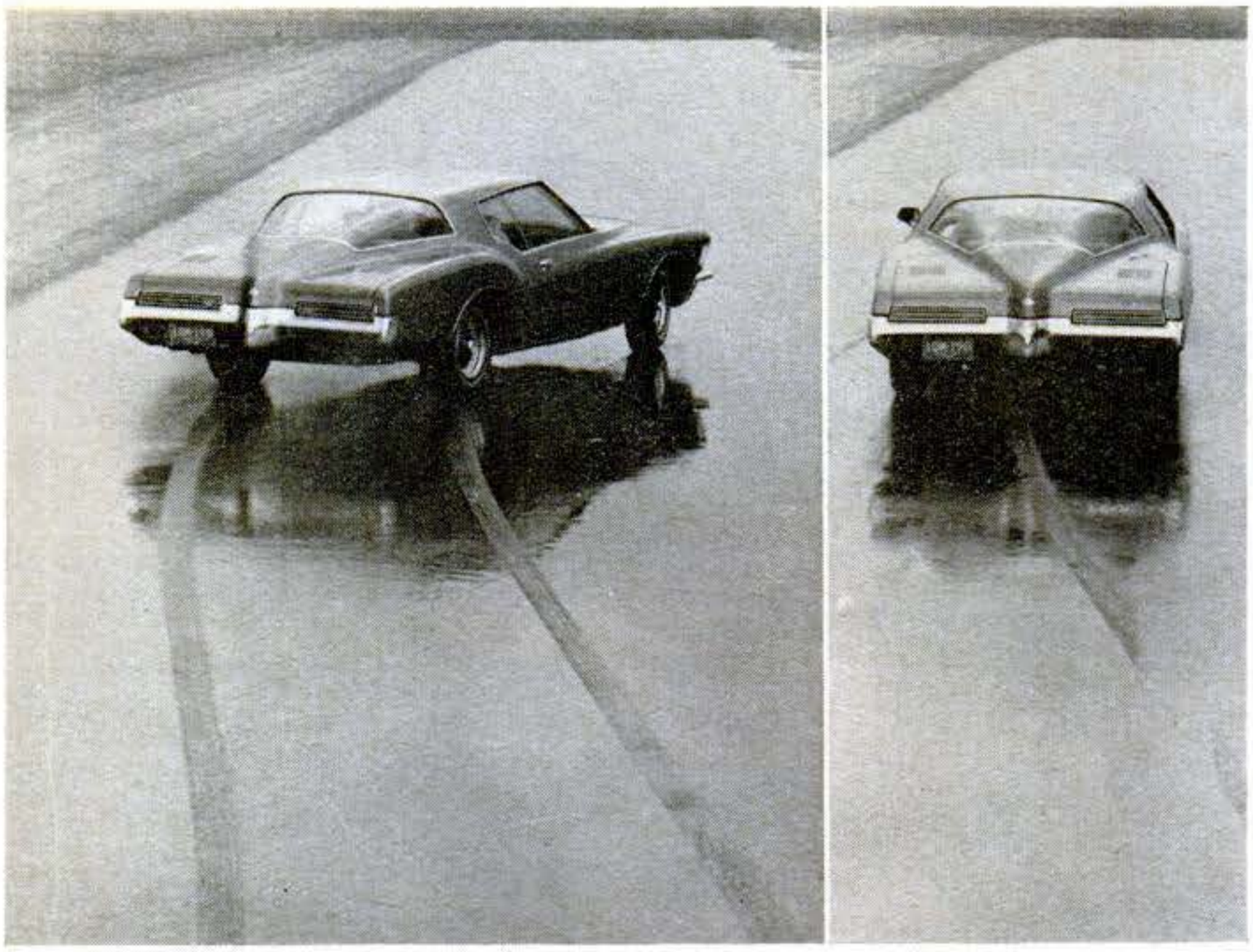
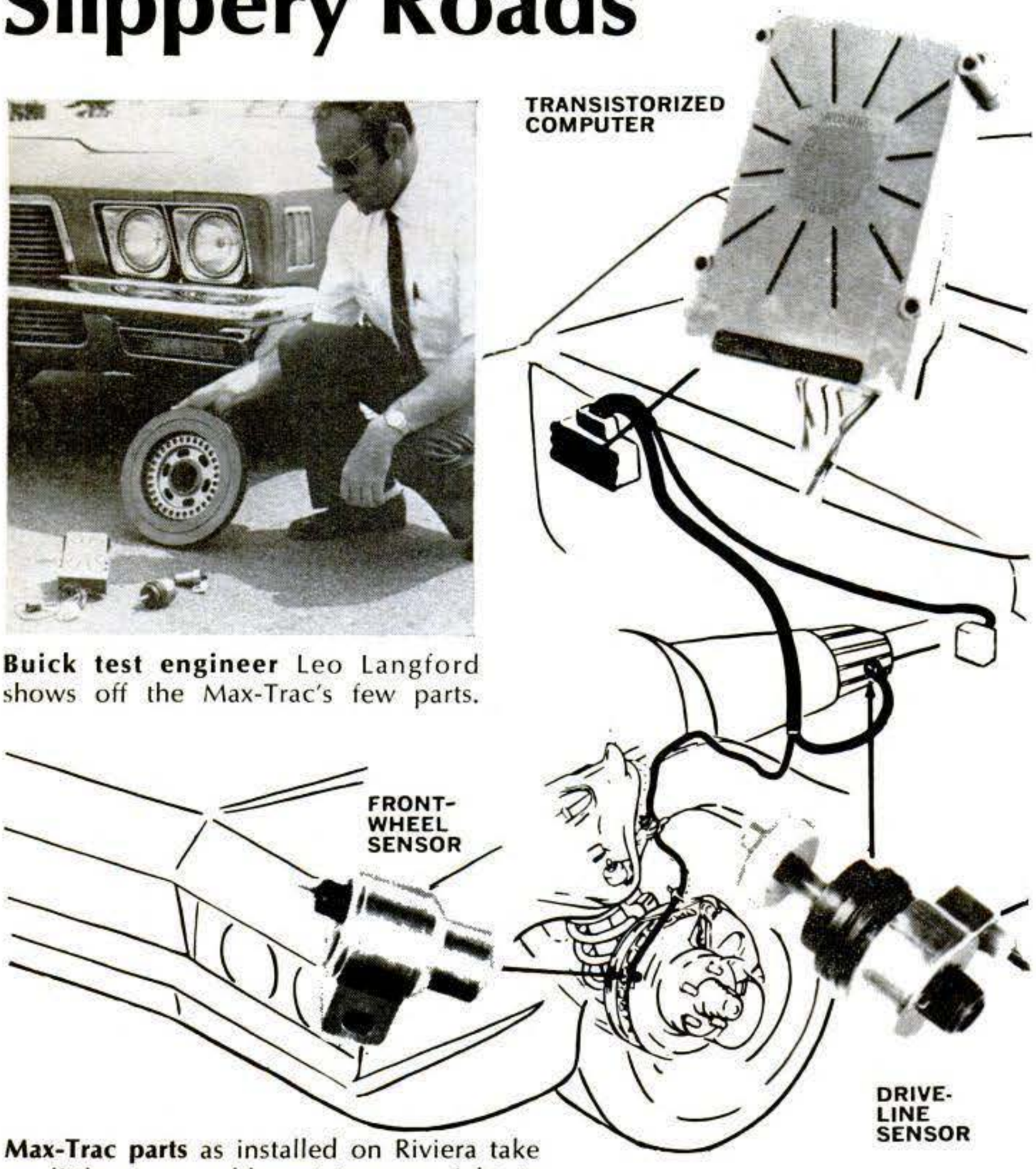


Riviera without Max-Trac (left) threatens to spin out during acceleration on wet asphalt. But with Max-Trac, at right, the car maintains straight course.

Now—Buick Offers Better Traction on Slippery Roads

Buick test engineer Leo Langford shows off the Max-Trac's few parts.



Max-Trac parts as installed on Riviera take up little space, add next to no weight to car. Computer is inside instrument panel.

With its new Max-Trac, Buick has introduced a fresh advance in wheelspin control. It does not replace Positraction—it's something extra, added to the limited-slip differential. It enables you to get going on ice and snow, just as with other antispin axles. But it does something more. It keeps the car traveling straight, without fishtailing.

It helps on turns, too. On an icy curve where another car might get into a tail-end skid and spin out, Max-Trac will keep the car on course. However, we're not saying it will handle icy curves at any speed. Max-Trac has no control over front-wheel skids nor does it provide any antilock effect for the brake system. But it does give an extra margin of safety on winding, slippery roads.

Just what is this Max-Trac, and how does it work? It's a small electronic computer with two sensors. One sensor is mounted at the transmission output line and measures rear-wheel speed. The other sensor is mounted on the left front-wheel hub and registers front-wheel speed. The transistorized computer constantly compares wheel-speed inputs from the sensors and when the rear wheels turn significantly faster than the front wheels, it goes into action.

It cuts the ignition! That's right. You see the 12-volt feed wire to the coil goes through the computer. Computer signals an oscillator to actuate a power switch hooked into the coil feed wire, breaking ignition circuit for 10 milliseconds.

There is no risk of stalling with such ultrashort interruptions, and the cycle can be repeated up to 50 times a second, depending on severity of wheelspin. The computer goes into action when rear wheels are turning 10 percent faster than front ones and remains in effect until the difference has dropped below eight percent. Wheelspin will end when there is a positive change in road-surface traction or the driver backs off on acceleration enough to let the rear wheels recover their grip.

In the meantime, Max-Trac keeps the car on course by cutting torque to below the point of breaking traction by frequent firing interruptions.

We tested Max-Trac by making full throttle starts on wet asphalt with front wheels cocked. First we tried a Riviera without Max-Trac. It went sideways in about 40 feet and needed vigorous counter-steering to avoid spinning out. Next, a Riviera with Max-Trac: some noise from the drive train, a slight shudder in the rear end—otherwise, uneventful. The car took off, answering to the helm normally, returning to a straight course as soon as we straightened the front wheels. It seemed like magic!

Buick is restricting Max-Trac to the Riviera at the moment, but it will become optional on the Le Sabre, Centurion, and Electra 225 during the '71 model year. Price? Under $100—and that should assure its popularity.

—*Jan P. Norbye* and *Jim Dunne*

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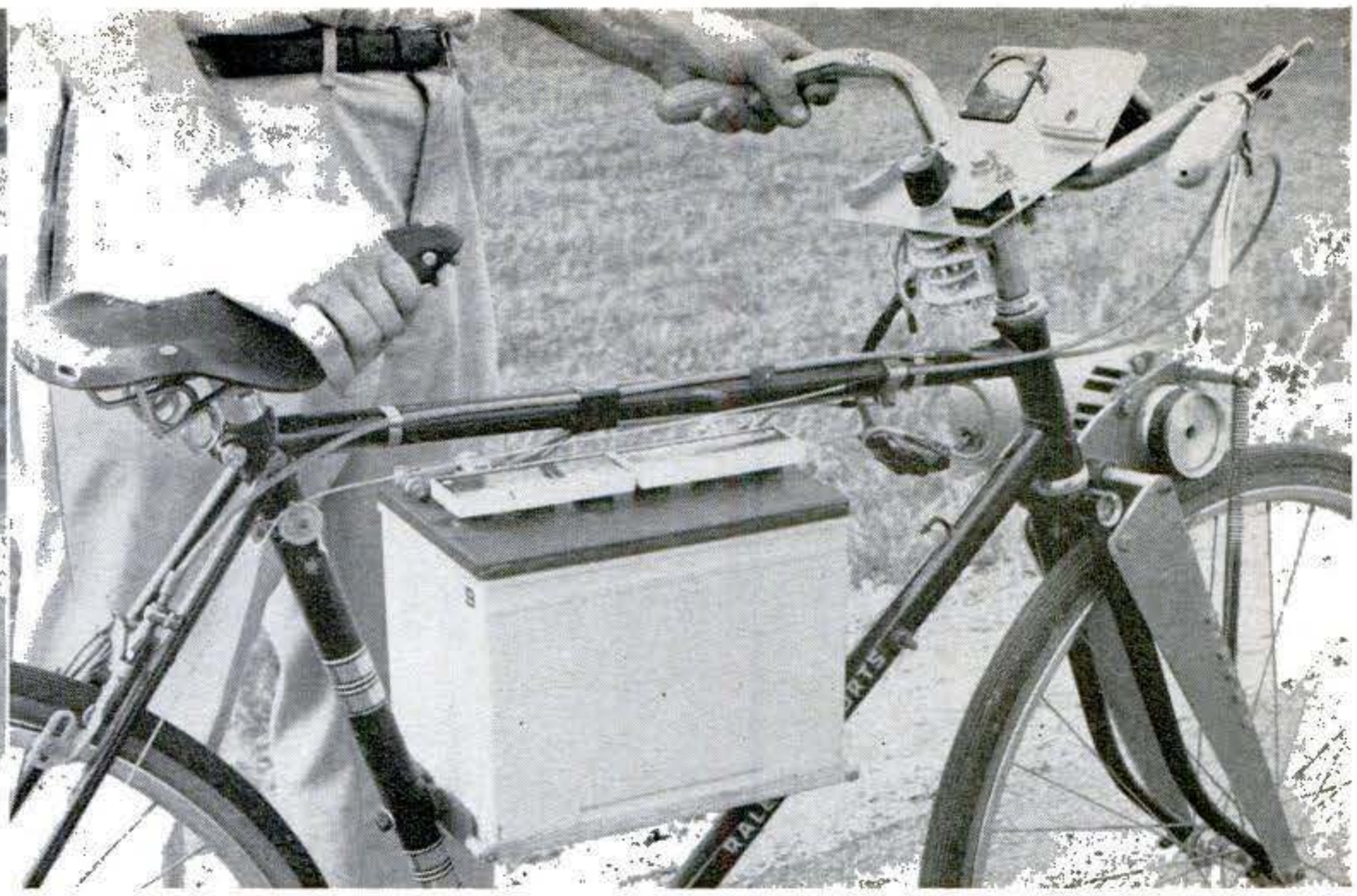
Battery does all the work as author zips along on his electrobike. On hills, soft dirt or sand, he helps out by pedaling.



A three-speed trolling motor drives the front wheel by friction. Pulley on the motor shaft, held against the tire by spring tension, rotates it. Instrument panel, mounting brackets for motor, and battery are home-made, as shown below.

How to Power a Bicycle with a Car Battery

On one charge, a three-speed trolling motor propels my wheel at 13 mph for 40 miles

By ROY PAANANEN

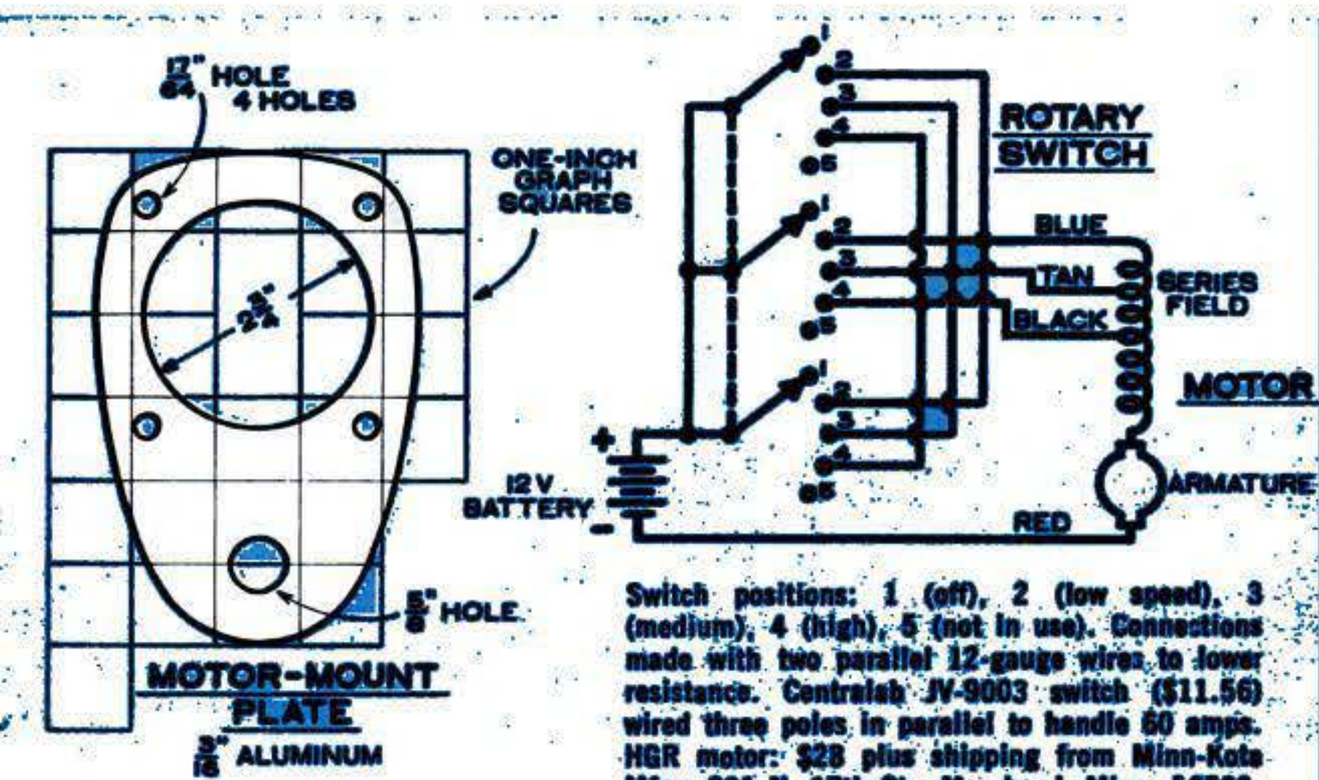
My answer to automobile-created pollution is an electric bicycle.

I'd advise you to put the components where I did. Weight distribution, center of gravity, and steering all work out best that way.

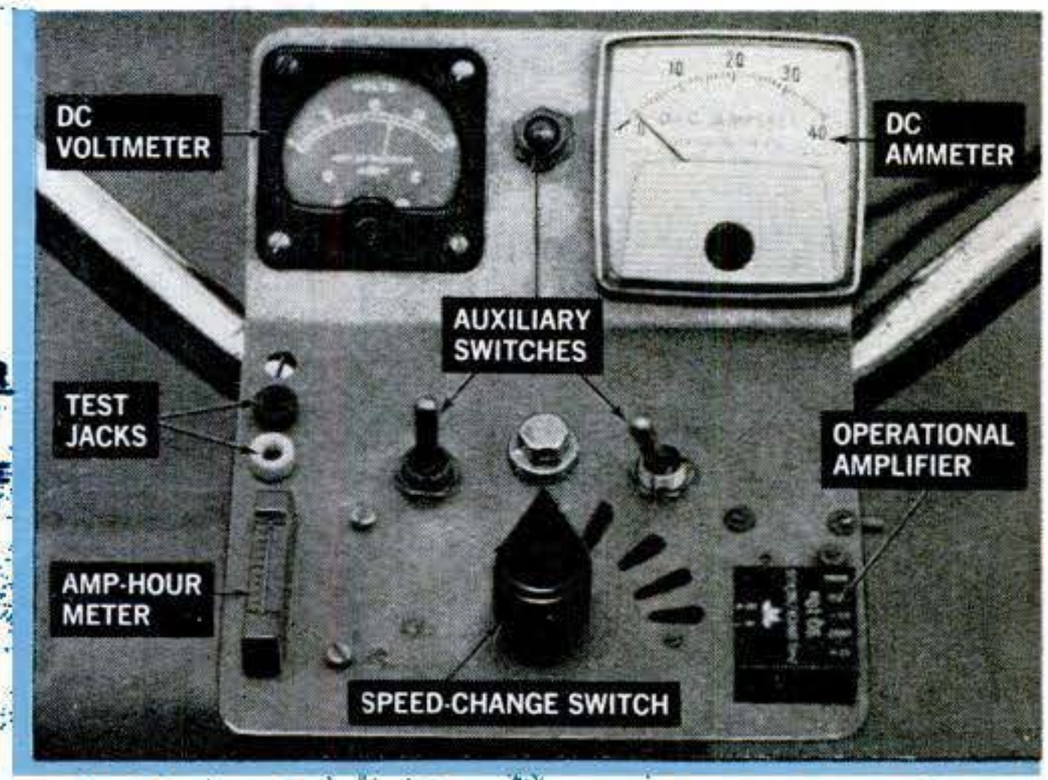
The motor mount consists of two aluminum side plates bolted to the front axle and forks. (You may want to use lead-washer spacers between plates and forks.) A shoulder bolt connects the top corners of the side plates and runs through a rotating sleeve that's bolted to the motor-mount plate. You move the motor-mount plate along the threaded sleeve until the motor-drive pulley is centered over the tire, then fix the plate's position by tightening 5/8" bolts on either side of it.

Friction drive. Pulley pressure against the tire is adjustable—you hook the lower end of the motormount

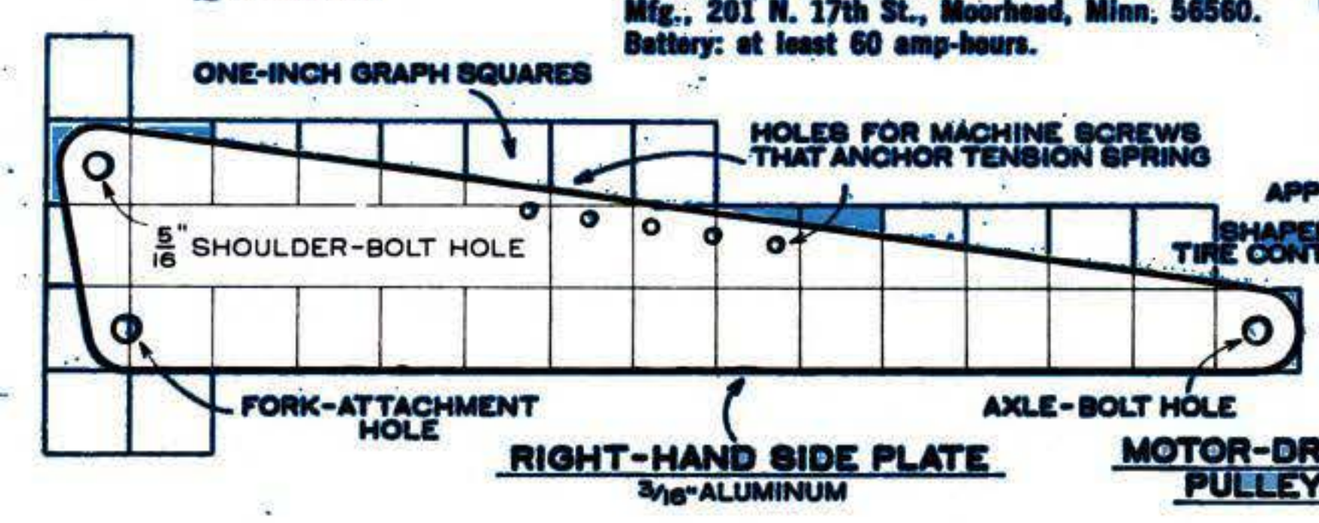
[Continued on page 130]

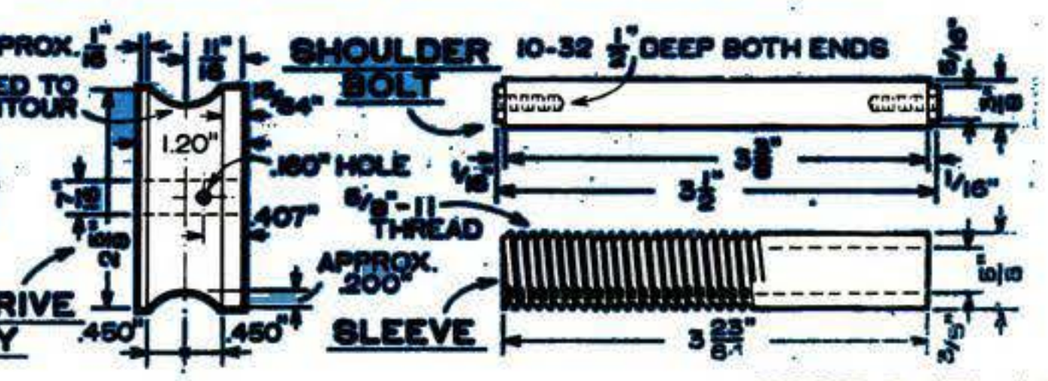


Switch positions: 1 (off), 2 (low speed), 3 (medium), 4 (high), 5 (not in use). Connections made with two parallel 12-gauge wires to lower resistance. Centralab JV-9003 switch ($11.56) wired three poles in parallel to handle 60 amps. HGR motor: $28 plus shipping from Minn-Kota Mfg., 201 N. 17th St., Moorhead, Minn. 56560. Battery: at least 60 amp-hours.



Only the speed control—a three-section rotary wafer switch—is essential to operate the bike. Other parts are optional, used by author in his experiments.





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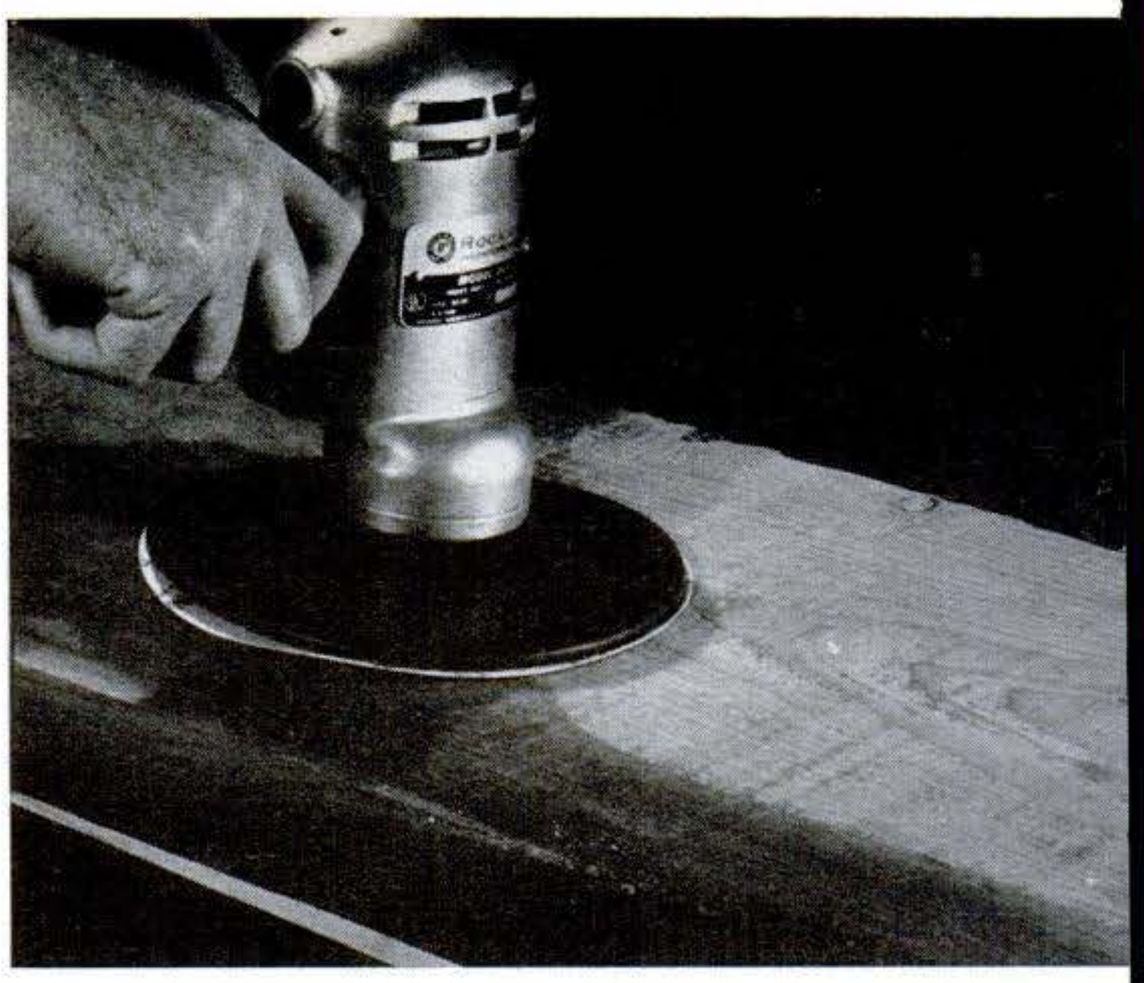
SANDER-POLISHERS: Who Needs 'Em?



You do—despite all the buffing and sanding accessories you can chuck in a portable drill. Here's how to choose the best for you

By R. J. DeCRISTOFORO

Let's talk about a category of portable tools that's often misunderstood and unappreciated—not only by the general public but, sometimes, by the manufacturers themselves. In researching this article, I asked one company for information on its sander-polisher and got back dope on a pad sander. Maybe everyone should call these handy tools *disk* sander-polishers to avoid confusion.

Once you decide to invest in one of these specialty tools, you have a basic choice to make. You can buy a sander *or* a polisher—or a two-speed unit that does both jobs. For the home craftsman, the dual-use tool makes sense. A check of the spec chart below will confirm that no compromise in quality is involved.

When two separate units are offered, the major difference is in speed. Polishers run at about half the speed required for efficient sanding. This is something to bear in mind if you're choosing between separate "either-or" tools: You *can* do a certain amount of sanding with a polisher, but you shouldn't try to do any polishing or buffing with a high-speed sander.

Some units are equipped (or can be, through the use of adapters) to take such accessories as drill chucks, wire wheels, and even grinding wheels. If you plan to use your tool for a wide variety of jobs, this may influence your choice. You may even want to consider an industrially rated tool like the eight-amp, 1¼-hp Powr-Kraft sander listed in the chart. Accessories for this unit include several grinding wheels. If your interests include welding, auto-body remodeling or repair, and heavy-duty sanding, check into this type of power package.

Offset vs. in-line. The in-line design resembles a portable drill. Motor weight is directly over the pressure area, with control handles in familiar positions.

The offset designs make a right-angle bend, so your hands are more widely separated. Since such tools have a longer body, they provide greater reach and are often handier for getting into tight places. For example, it's easier to reach the centerline of an automobile roof with an offset polisher.

For average jobs, though, the in-line design will probably feel more natural for most people. It seems easier to let the tool weight supply pressure to the pad. With an offset, I find my left hand applying pressure while my right hand guides. No harm done—you just have to learn a new handling technique before you're comfortable with the tool. There are more important considerations in deciding which make and model to buy—namely power, disk size, and availability of accessories.

In many situations, a portable disk sander will remove more stock faster than a belt sander. It will never do as smooth a final sanding, but it's not designed for that. Use it for quick smoothing of rough stock, "taking down" and feathering of fiberglass work and filled dents on automobiles, refinishing of metal surfaces, removal of old paint and varnish—even (with the proper abrasive)

How major makes and models compare

Make	Model or Catalog No.	Size	Shaft Design	Speed (rpm)	Sander	Polisher	Hp	Amps	Weight (lbs.)	Bearings	Price
Black & Decker	7950	7"	Offset	4000	X		⅞	7	7¼	ball and roller	$69.95
	7970	7"	Offset	2000		X	⅞	7	7½	ball and roller	69.95
Montgomery Ward (Powr-Kraft)	84B 8577	7"	Offset	1800 3400	X	X	½	6	10[1]	needle and bronze	39.44
	84B 8541M	7"	In-line	5000	X[2]		1¼	8	14[1]	ball	68.95
Rockwell	304	7"	In-line	4000	X		NA	4	5¾	ball	74.50
	305	7"	In-line	2000		X	NA	4	5¾	ball	74.50
	470	7"	Offset	4500	X		NA	8	8½	ball	95.00
	471	7"	Offset	2100		X	NA	8	8½	ball	95.00
Sears (Craftsman)	9 H 1151	6"	In-line	3500 4200	X	X	¾	NA	7⅜[1]	ball and needle	39.50
	9 H 1155	7"	Offset	2400 4700[3]	X	X	1½	NA	14¾[1]	ball	79.50
Skil	120	6"[4]	In-line	2000	X	X	¼	3	3¼	ball	32.88
Wen	940	7"	Offset	1800 3400	X	X	½	6	7	needle	49.95
	1040	9"	Offset[5]	low-high		X	½	6	9	needle	59.95

NOTES: 1. Shipping weight, packaged. 2. Actually a disk sander-grinder. 3. Same basic tool offered as sander only ($10 less). 4. 6" bonnet, 5" disk. 5. Has oscillating head.

For floor polishing, you can make a pivoting yoke out of 2" stock that lets you attach an extension handle—four feet of ¾" aluminum tube. Bolt into side handle holes.

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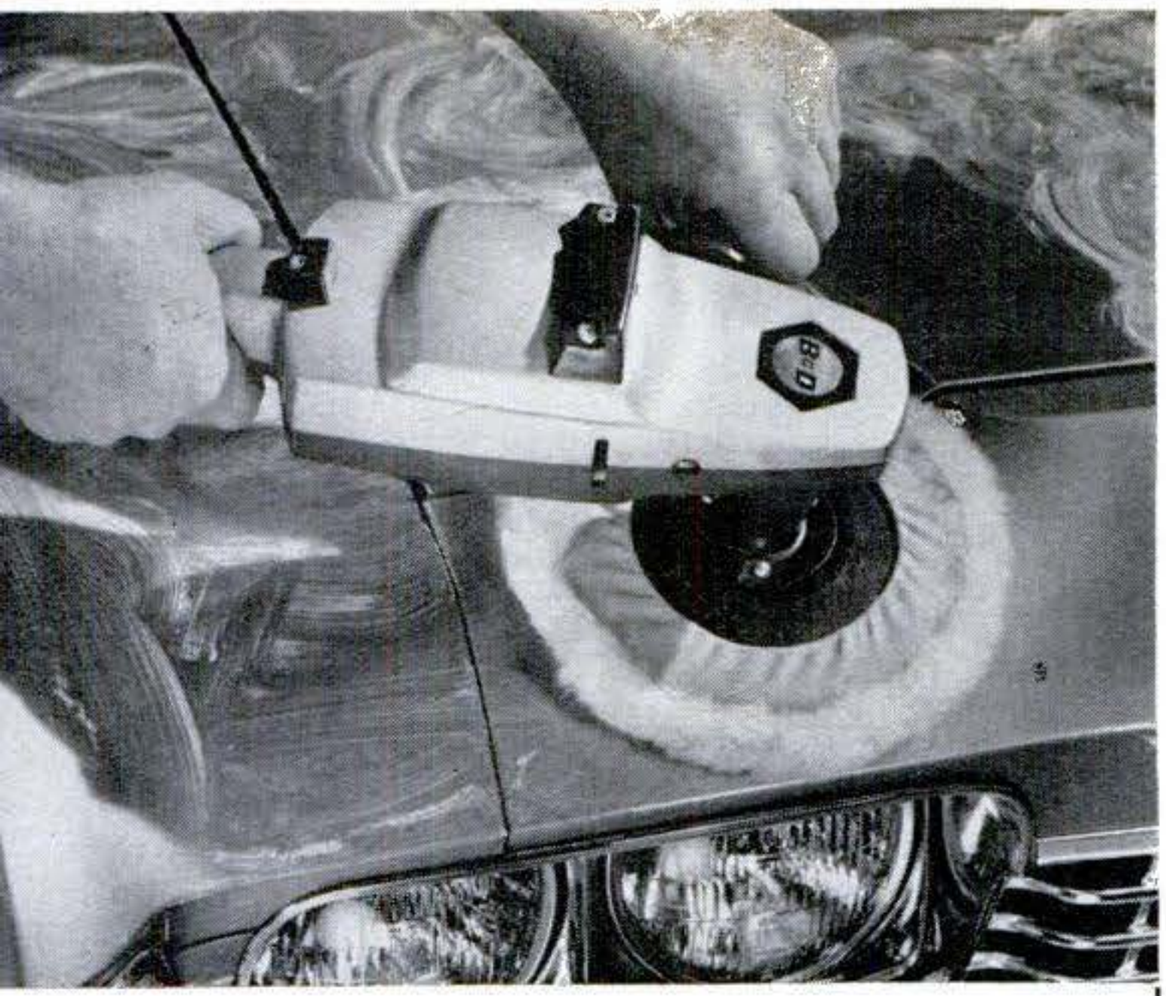


Tips on car polishing

Wash car to remove all dirt and grease, using special solvents for road tars. Park car out of sun. A liquid combination cleaner-polish works best, but be sure it contains no abrasives. Follow label instructions to apply, working from top of car down. Let dry.

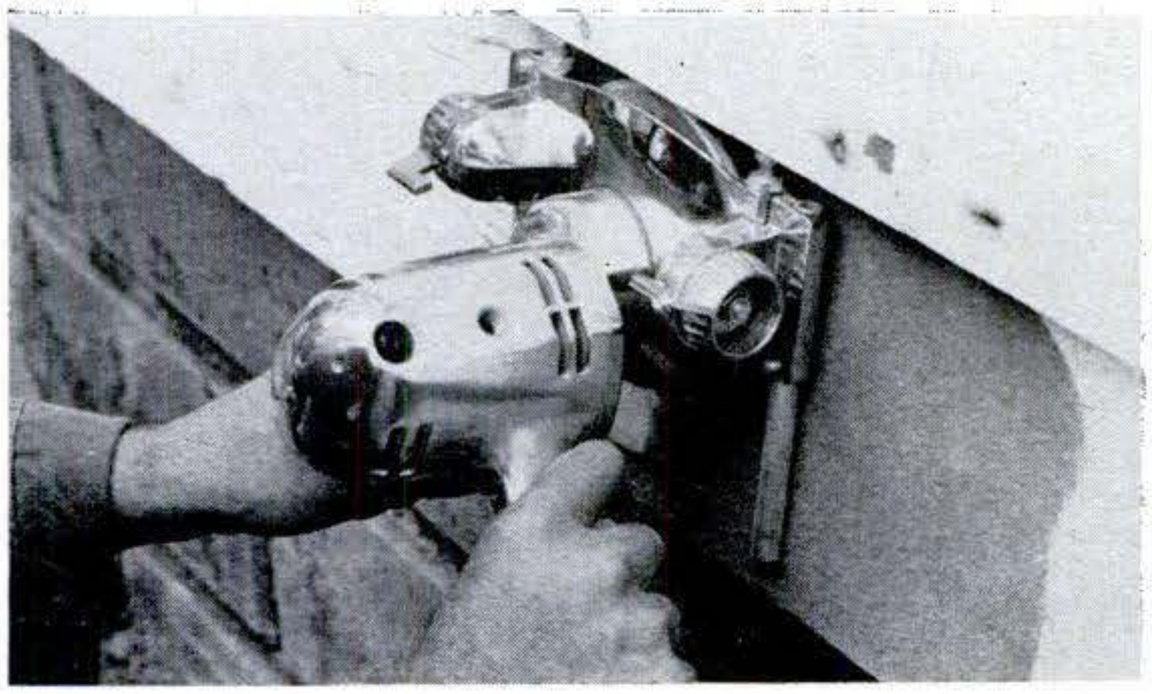
Best bet is to start with a pile-fabric pad (available as an accessory) mounted on standard rubber backup pad. Again, start at top of car and work down; use long strokes, letting weight of tool supply pressure. Don't worry about missed corners; bonnet will take care of them in next operation.

Replace fabric pad with lamb's-wool bonnet and go over the car again to buff finish to high luster. If your car hasn't had this kind of attention for awhile, you may have to repeat operation for new-car sheen. Then occasional touch with bonnet will keep finish looking good until another wax application is in order.

smoothing down stone or concrete. I call that versatile.

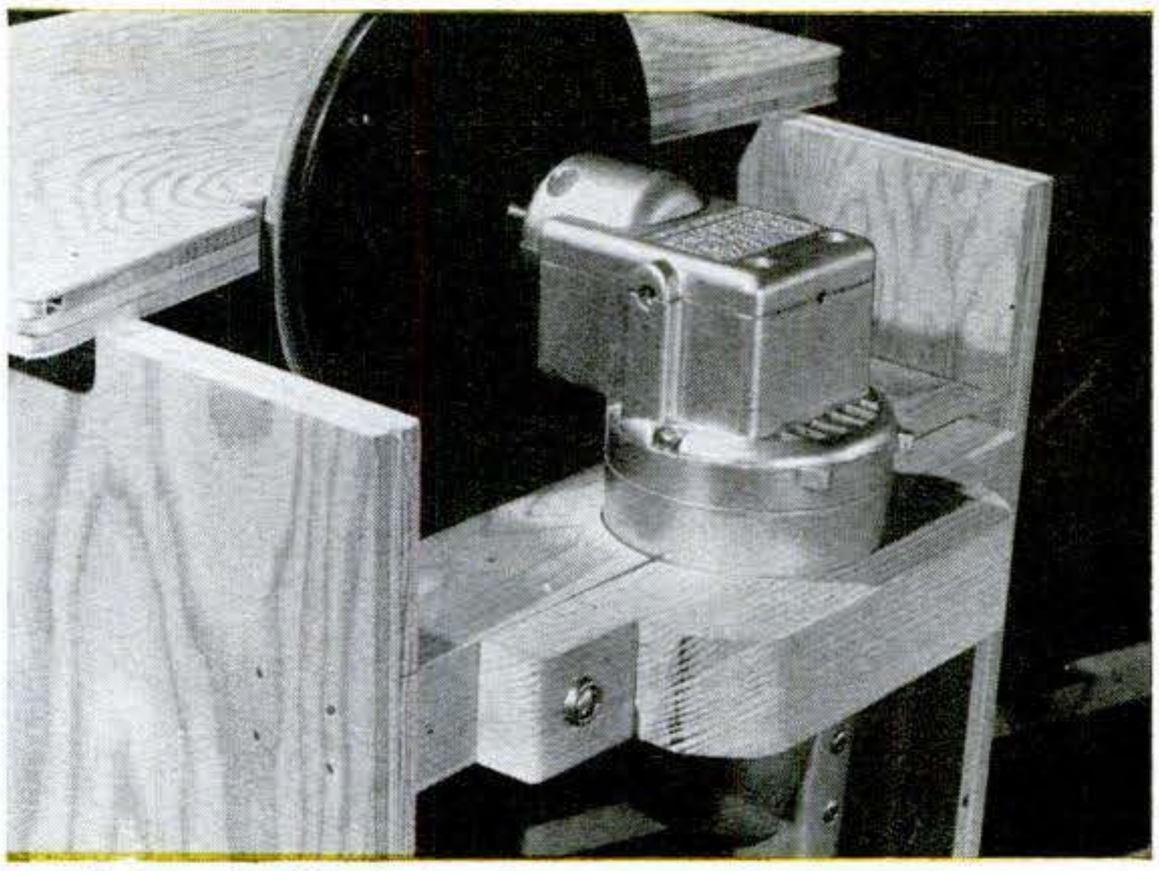
For fine finishing, it's the tool to use before you take over with a belt or pad sander. Often, by working through progressively finer grits of paper, you can go directly from disk to pad. Less critical surface preparation—as for exterior painting—may require nothing beyond the disk, especially if you use one of the new foam backup pads with a fine (No. 1) paper.

[Continued on page 139]

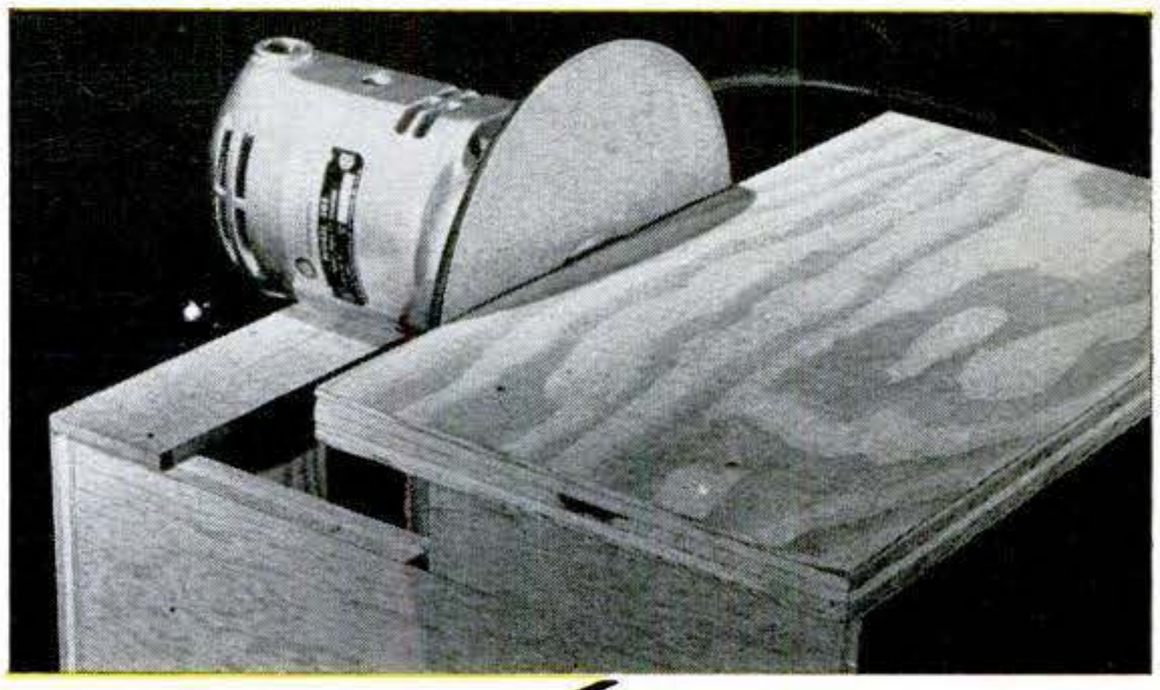


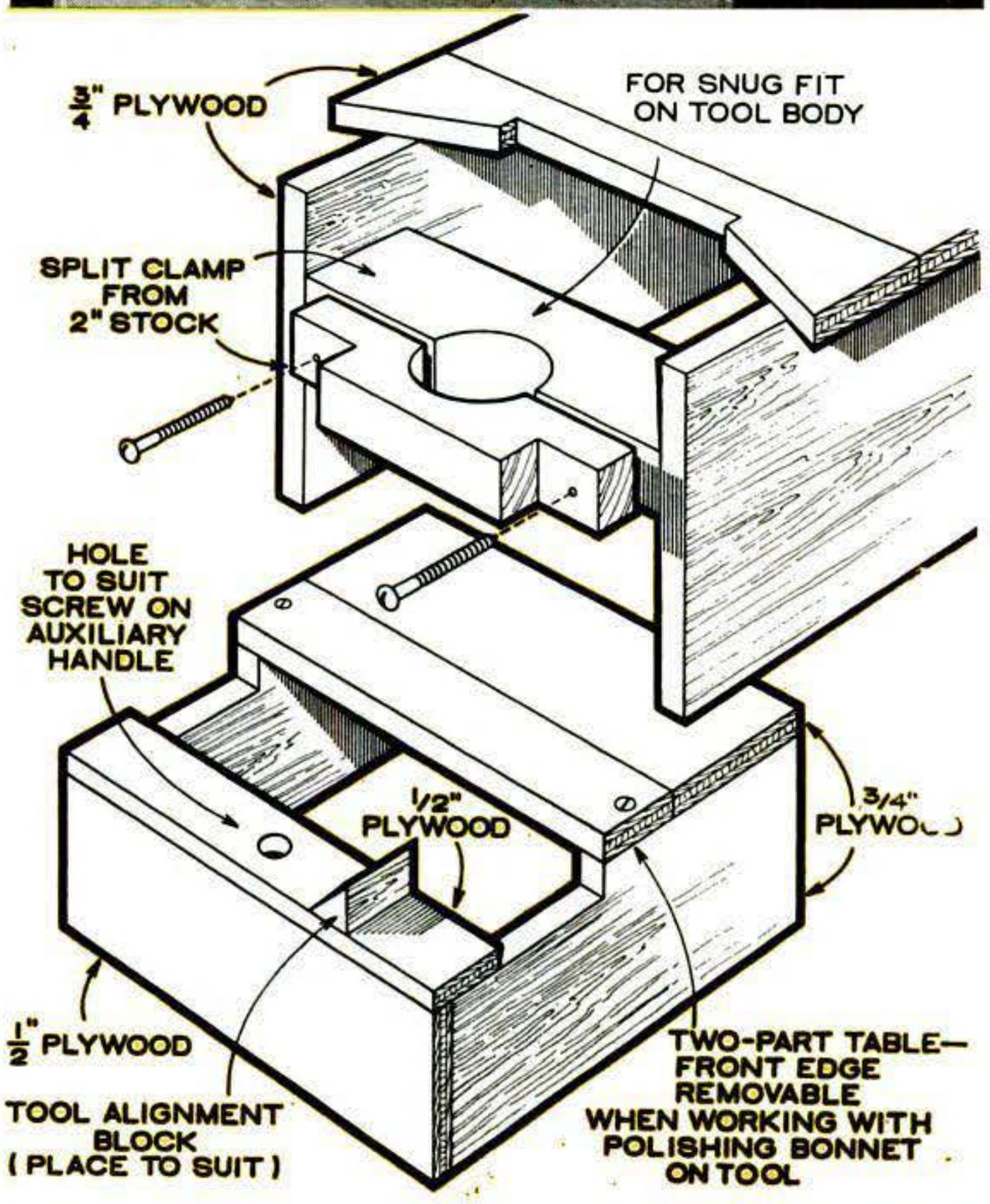
Controlled sanding of vertical or horizontal surfaces is provided by this accessory for the Rockwell-Delta sander. Adjustments control depth of surface removal and let you sand flush along an edge, as above. All you do, then, is set the pace of the tool.

For stationary mounting, build a plywood table



Choice of table design depends on whether your tool is offset (above) or in-line (below). Split clamp for former holds it firmly, yet permits quick removal. In-line models are mounted by means of tapped hole provided for handle.





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KAWASAKI'S Adjustable 350: Ready for Road or Rough

Exploring a desert wash, Big Horn displays the rugged side of its nature. Oversize wheels, trials' universal tires give you a sure-footed ride off the road; five speeds match torque to the terrain.

Enduro features abound—raised fenders, skid plate, folding footpegs, tucked-in muffler. Kawasaki extras include CD ignition, foot controls on either side, waterproof electrics.

With three-position forks and five-way rear suspension, the Big Horn handles anywhere

By **JIM DAVIS** / *PS West Coast Editor*

Want a cycle that you can ride to work all week and then bomb through the bushes when the weekend comes? Well, I believe I've found one. It's the Kawasaki Big Horn, a highly unusual machine bristling with novel features.

Let's start with the Hatta front forks. They're adjustable in three ways: You can move the fork tubes up and down in the crown to change their effective length. You can move the base of the forks on the axle to any of three positions. And you can adjust the fork springs to any of three tensions. Voila! a front end customized to match your weight and use of the machine.

Let me add that the progressively wound springs on the rear shocks are five-way adjustable and have a full four inches of travel. Add to this one of the softest and widest seats I've put my rump on in a long time, and you end up with handling and a ride that, believe me, is difficult to beat.

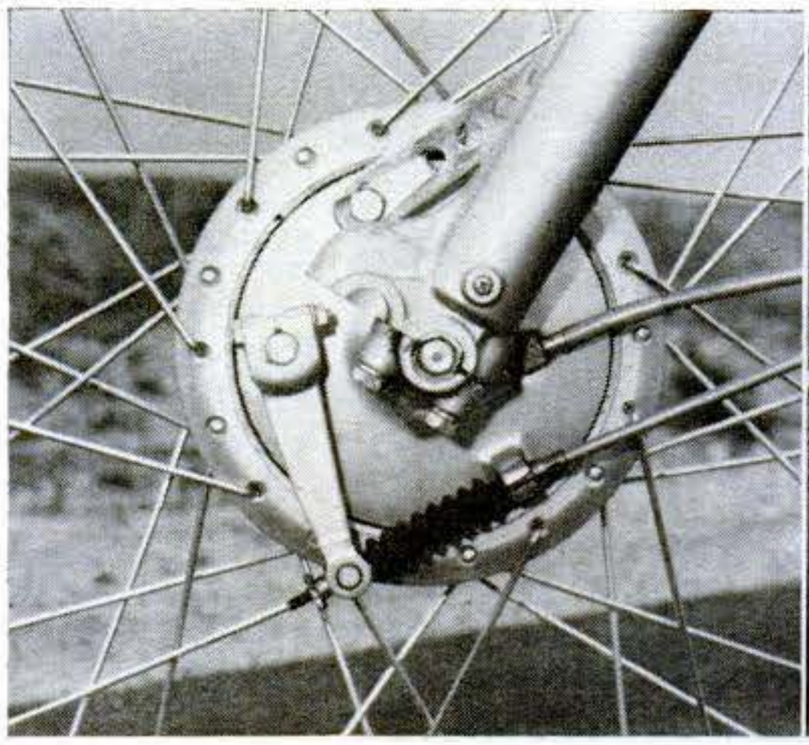
Power aplenty. The Big Horn's engine has a big displacement for a two-stroke single, made practical only recently as design problems—like thermal efficiency and exhaust scavenging—have been solved. Its maximum horsepower develops at an easy 6,500 rpm, maximum torque at 1,000 rpm less. I really enjoyed this kind of power for riding in the woods, and found it perfect for working through Los Angeles traffic, as well.

If 33 hp isn't enough for you, there's a powerpack that boosts output to 45 hp without increasing revs.

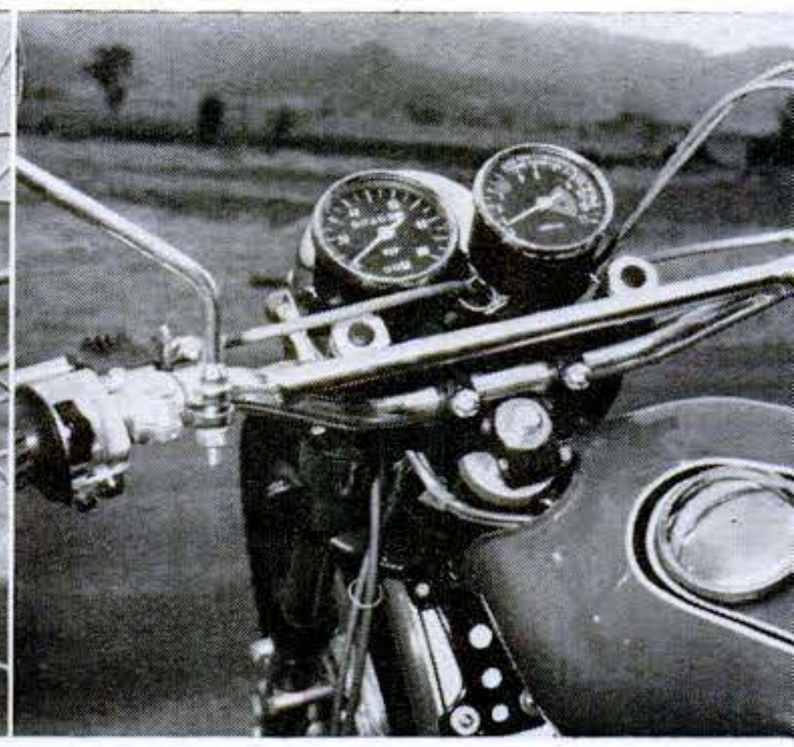
All the extras. The Mikuni 32mm

KAWASAKI 350 SPECS

Engine	One-cylinder two-stroke, rotary-valve
Displacement	346cc
Bore x stroke	80.5 x 68mm
Comp. ratio	6.8 to 1
Horsepower	33 @ 6,500 rpm
Torque	28 lb.-ft.
Clutch	Wet, multidisk
Gearbox	Five-speed
Tires	Front: 3.00 x 21 Rear: 4.00 x 18
Elec. system	Battery/alternator
Ignition	Capacitor discharge
Gas tank	3-gal.
Weight	265 lbs.
Length	82 in.
Ground clear.	9 in.
Braking dist.	39 ft. @ 31 mph
Price	$885 (f.o.b. Norfolk)



By loosening the axle nuts you can shift the front forks forward or back, changing their angle and the bike's wheelbase for best handling on rough stuff or highway.



100-mph speedometer (on left) has regular and trip odometers; latter's three digits show tenths of a mile. Tach goes to 11,000 rpm. Brace strengthens handlebars.

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rburetor compensates for altitude, that you don't run out of power en you're riding in the mountains d the air gets thinner.

A capacitor-discharge system arks the Champion L-19V plugs. u never have to reset the plug gap, just the breaker points, or fool with factory-set timing. The spark is remely hot, which means more mplete combustion with less chance fouling the plug. An added bonus: ter gas mileage.

Mixing gas and oil in a big can d dumping the mixture into the e is another thing of the past. I t put gasoline in one tank, oil in other, and let the automatic Inject-be system take care of the lubri-ion.

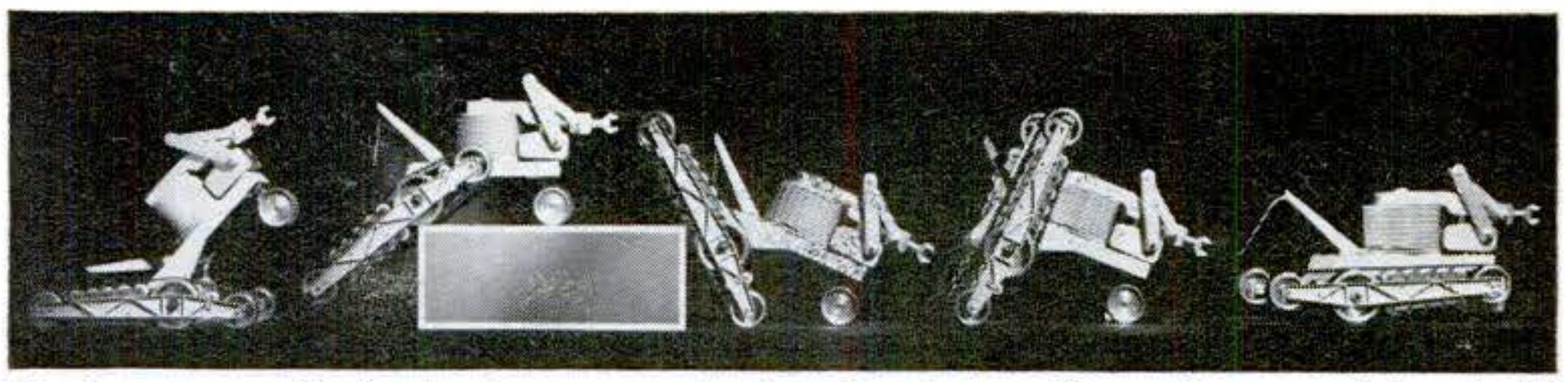
Most off-road motorcycles don't ed much in the brake department, cause of their lower gearing and wer speeds over rough terrain. But Big Horn will also be used on the eet, and for that I feel it could use it more stopping power. Both in-nal-expanding, single-leading-shoe kes seem adequate for just about rything except repeated fast stops ere brake fade poses a problem.

fabulous handling. Kawasakis are own for this, and the Big Horn is exception. I spent over a week ing the test bike to and from my ce and out in the vast Mojave sert. I really dug it. Nothing ld faze it. Handling is quick, but so lightning-fast that you'd tend get into trouble. The big 21-inch nt wheel at the end of that neat pension seems to float over almost ry obstacle.

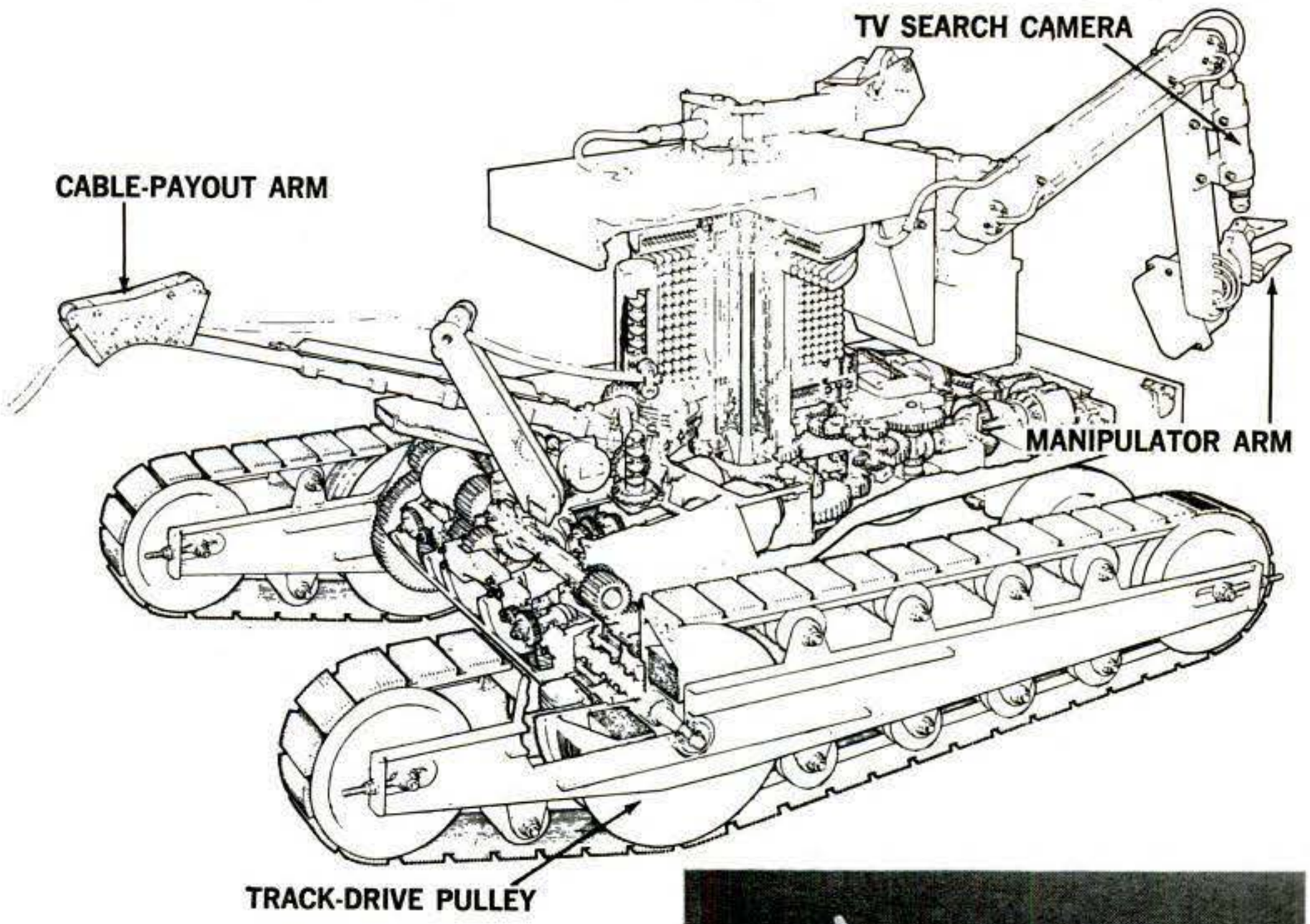
Riding tandem, I spent several urs chasing jackrabbits and soon got a passenger was aboard.

Many a motorcycle is touted as a e dual-purpose job—one that's at me on street or trail. For my ney, the Kawasaki Big Horn is closest thing to it so far.

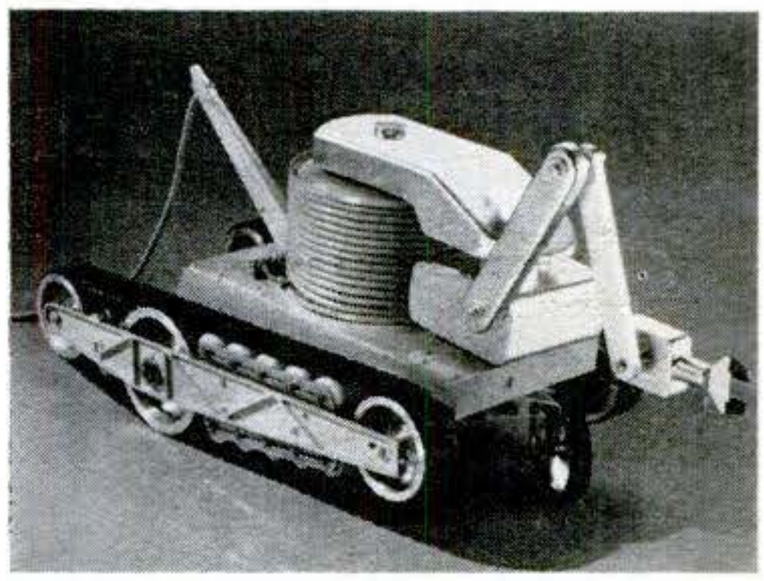
t flips up when you pull a lever, un-ering air cleaner and battery. Tank the side holds engine oil for the two-ke's automatic oil-injection system.



Rivet rears on its tracks to surmount obstacle, then rolls on its top, rights itself.



RIVET: The Acrobatic Tractor



Working model shows how Rivet will look. Full-size remote-controlled manipulator will be 4½ feet long and weigh 450 pounds.

Rivet's a do-anything tractor that can mount and descend stairs, crawl over obstacles, climb 45-degree slopes, turn in its own length, and find its way out if boxed in or accidentally turned over.

Rivaling a man in agility, and far exceeding one in strength, the 4½-foot-long machine weighs 450 pounds. Its manipulator arm swings in all directions and can hold an 80-pound load at its full reach of 4½ feet.

Rivet (an acronym for Remote Inspection Vehicle Telechiric) was designed by the United Kingdom Atomic Energy Authority for damage control and rescue work following a reactor accident; but it could be used in any hazardous situation.

Powered by two electric motors, Rivet has tracks driven by a single off-center pulley and suspended on that one axis. Each track has three faces of different lengths, and the entire assembly can be tilted or turned over on its axis to adjust for the angle of climb or to alter the effective length or wheelbase of the vehicle. And that's not all!

The chassis can also be angled relative to the tracks to approach or surmount obstacles. And there's a steerable two-wheel bogey that gives the Rivet the maneuverability of a dodge-'em car.

The manipulator arm, mounted on a telescopic turret, can be extended to total height of 5½ feet. Rivet can also be positioned to bring a TV search camera to bear on objects anywhere above or below itself.

Payout and recovery of the cable are fully automatic: The drum and cable-winding mechanism are controlled by a tension-sensing device on the payout arm.—*David Scott*

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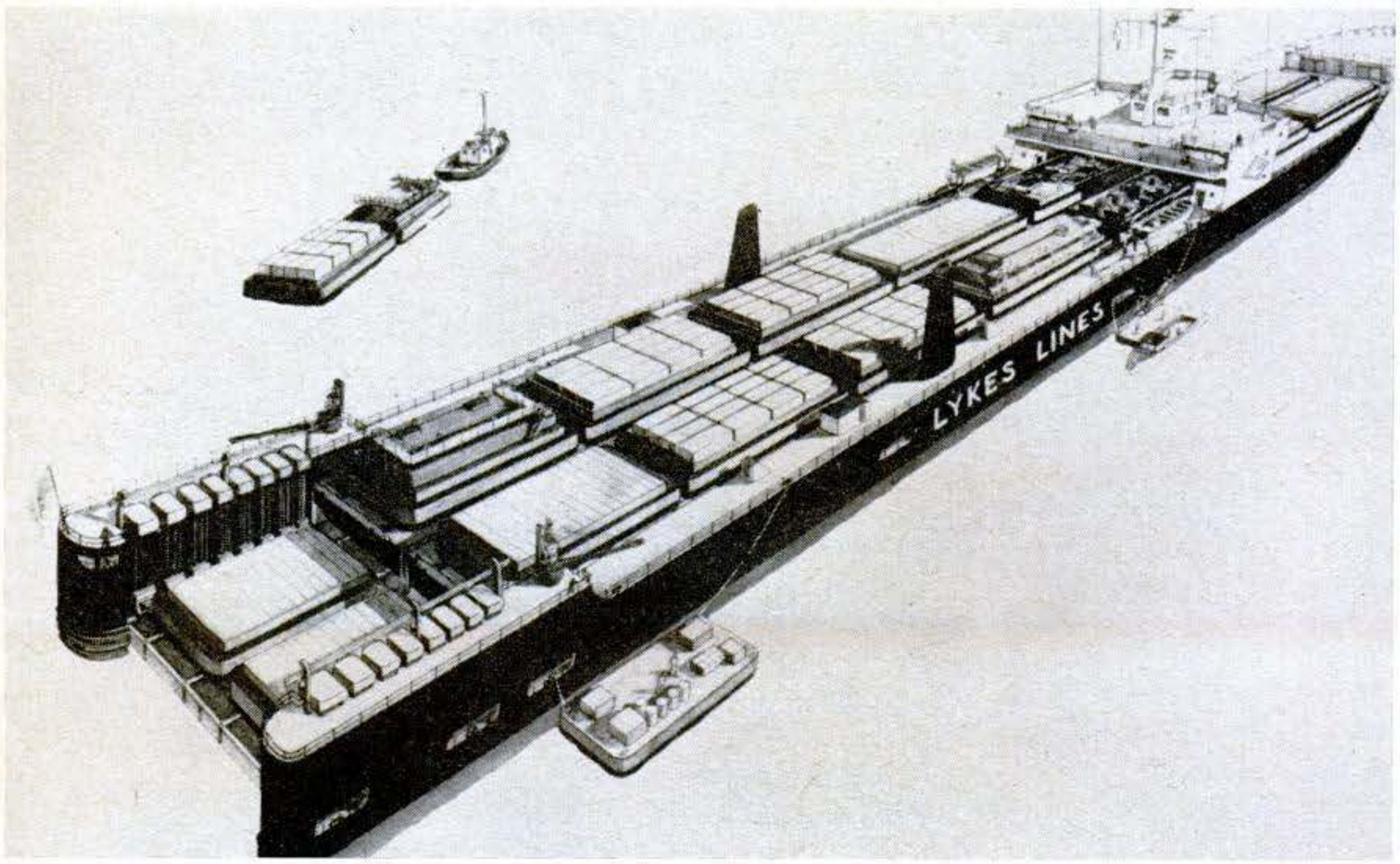
What's New

A PICTURE ROUNDUP OF NEW PRODUCTS AND DEVELOPMENTS



↑ Piggyback cargo carrying adapted to the high seas

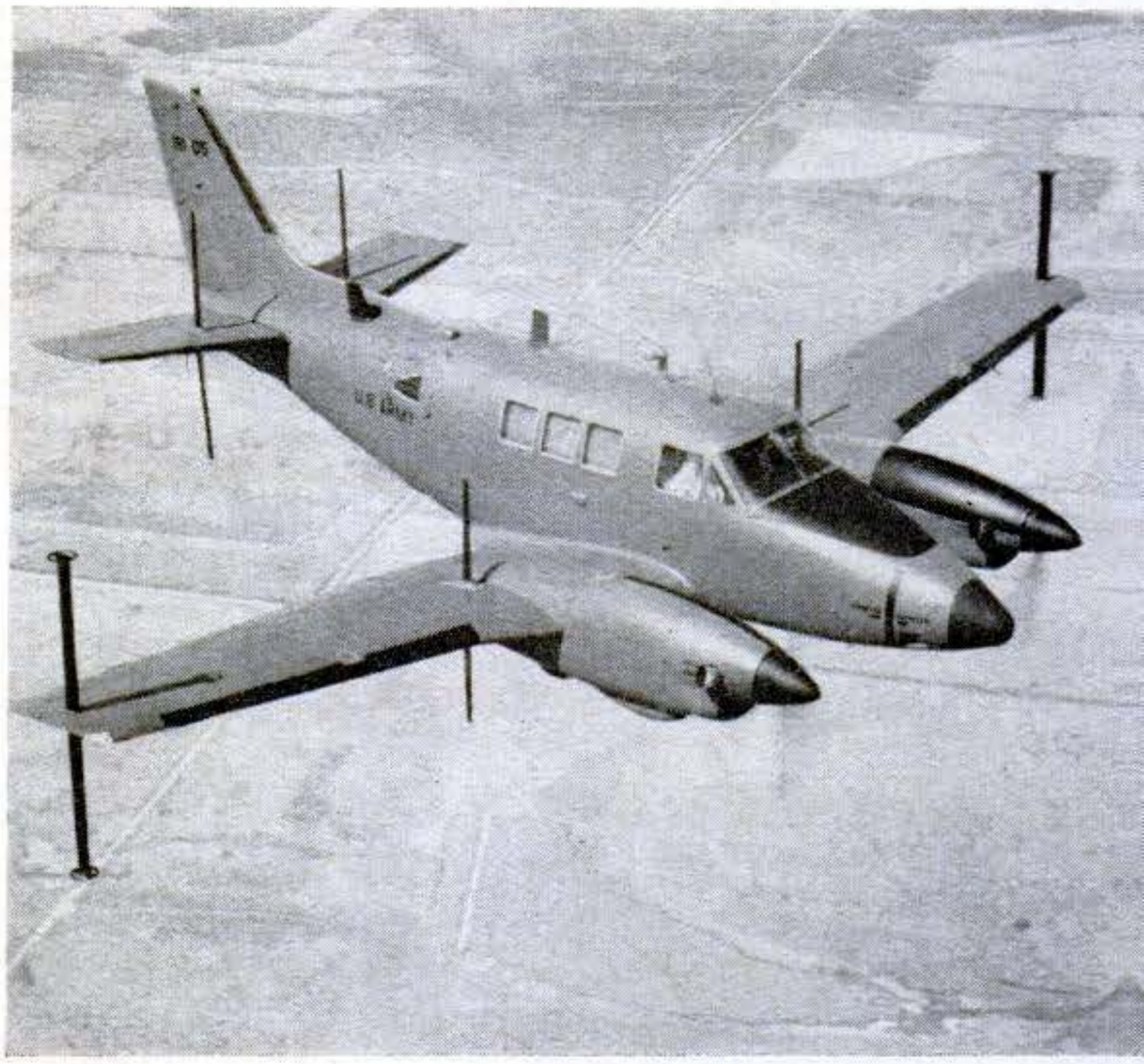
A huge open stern and a giant 850-ton elevator keynote the design of the new Lykes class of cargo ships. Barges, each loaded with 850 tons of cargo, can be floated into the open stern of the ship, then lifted up to deck level by the elevator. Placed on dollies, they are rolled into position on deck for the voyage. At destination, the barges are refloated, then carry their cargo to shore or move on up rivers and canals to inland ports. The first of the new ships is now being built by General Dynamics.

Soup in a tube ↑

Monopaste (thickened monoc bath) and a plastic processoc will soup a roll of 35mm filnm in five minutes—and ini broad daylight. The new systemm was developed by the Aii Force to provide a means oc quick field processing foc black-and-white filmm

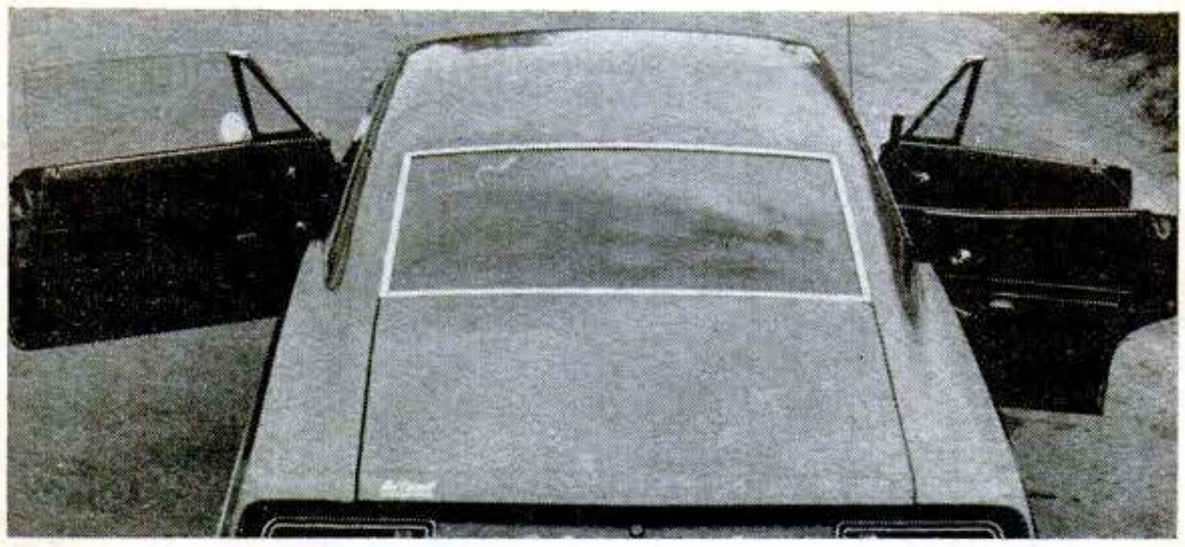
← Blanket protection

Firestone is working on an alternative to the air-bag passenger-restraint system. Their trick: a blanket that springs up automatically in case of a collision, keeping passengers from being hurled forward. Unlike the air bag, it leaves the driver's view unobstructed.



Special-mission plane ↑

Reconnaissance is the mission of this Beech-built Army RU-21E. The twin-engine turboprop plane is a "special-mission" version of the Army's U-21A utility transport series. Photo above is the first one released showing the craft.



← Three-door sedan

When Ted Clark of Lowden, Iowa, bought this Pontiac, the four-door was all smashed up on the left side. Reworking the damaged sheet metal, he replaced the two left doors with a single wider door from a two-door. Presto! A three-door sedan!

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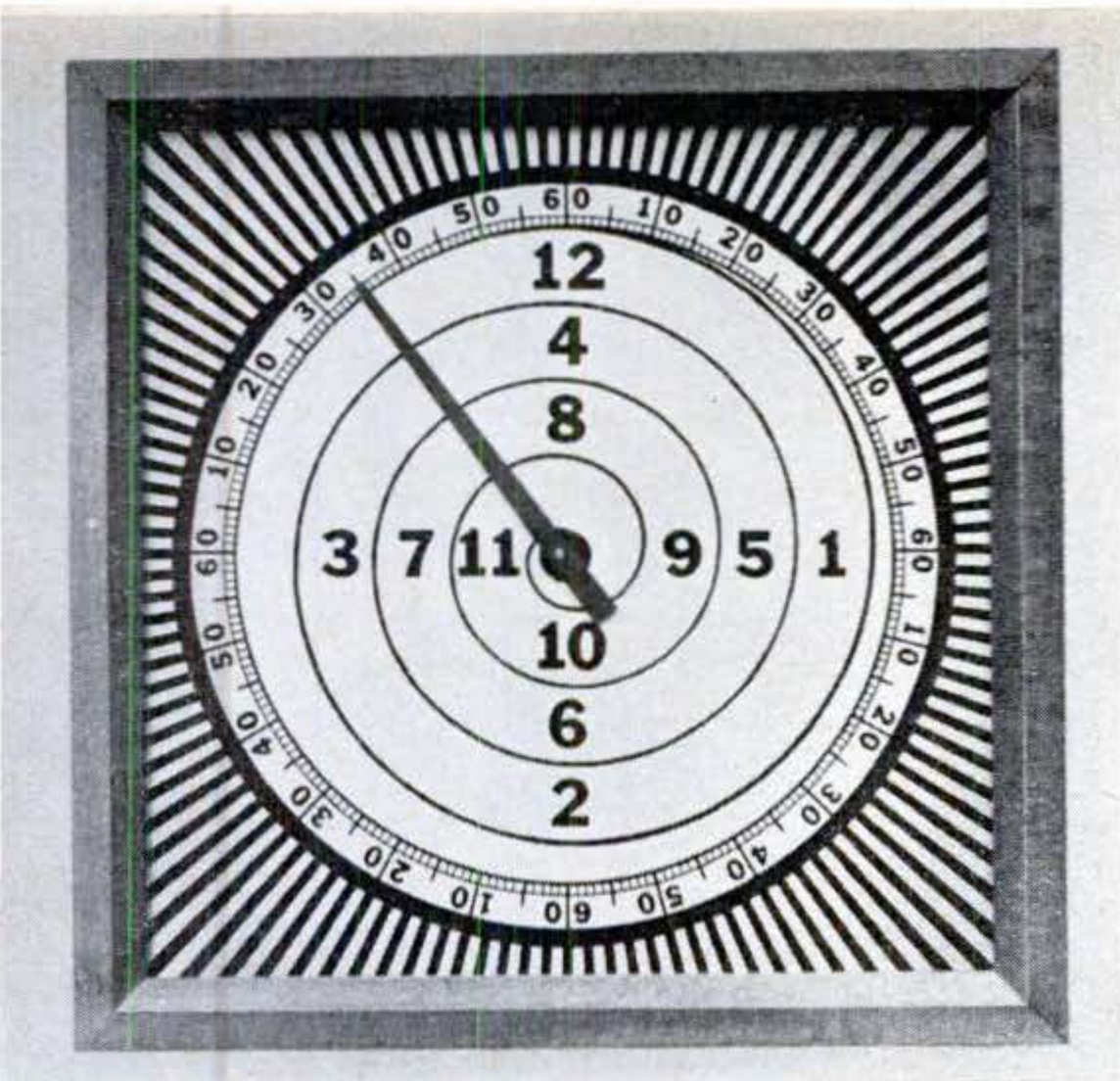
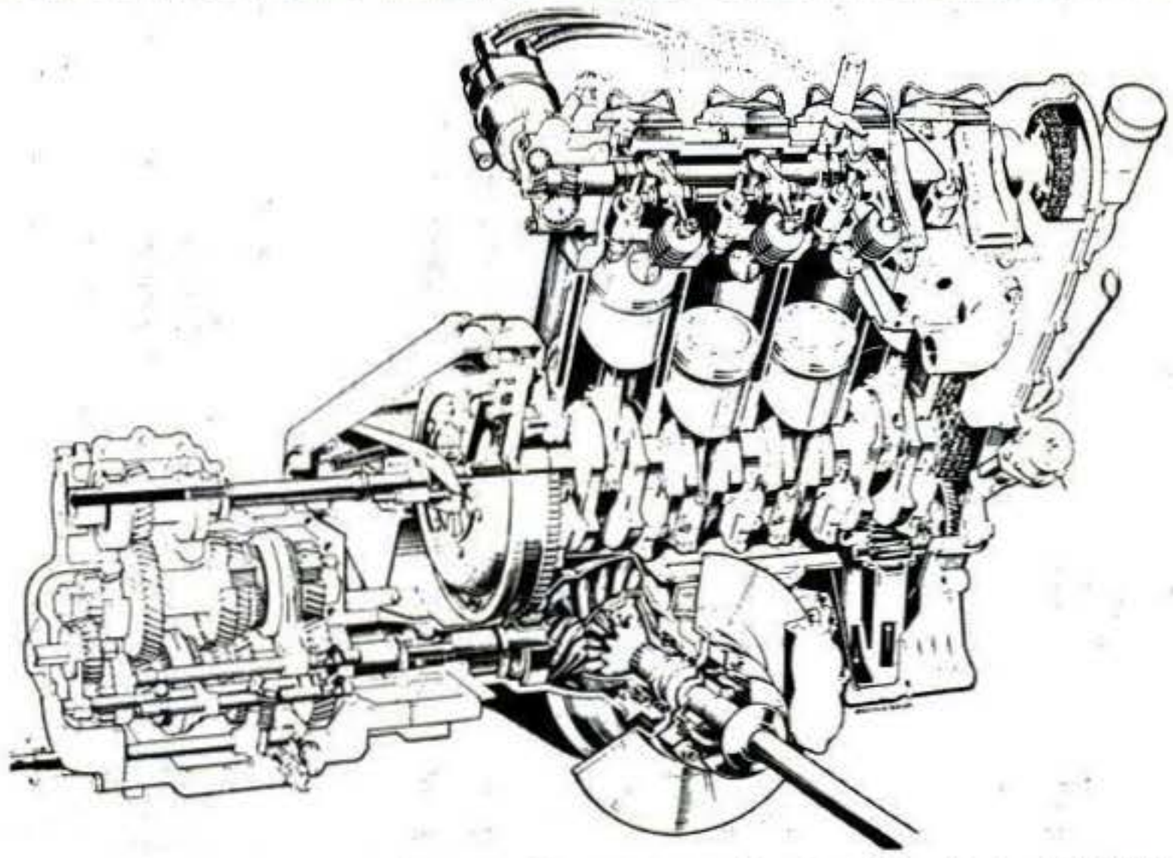


A clock that's 200 years behind time

The idea for this one-hand clock was originated by Benjamin Franklin in 1770. Two hundred years later the clock has finally reached the market. It's divided into quadrants, each divided into 60 minutes. The clock above reads either 3:35, 7:35, or 11:35. Since you always know about what hour of the day it is, you can discard the two irrelevant times and come up with the one that counts. The 12-inch clock is $25 from Precision Graphics, 3 Pond St., Norton, Mass. 02766.



It's pull, not push, for the latest VW

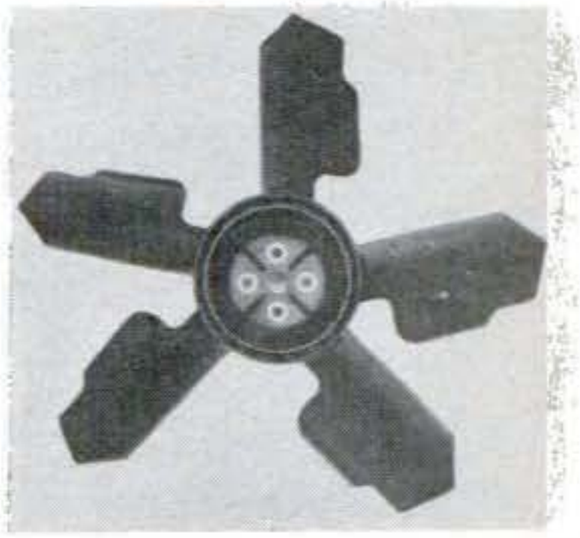
When Volkswagen took over the NSU factory, they inherited the NSU K70, about to hit the market. Now it's the Volkswagen K70 and it's a far cry from any of the other VW designs. It has a water-cooled, overhead-cam engine driving the front wheels—rather than the air-cooled engine driving rear wheels on all the other VWs. The 90-inch engine puts out a horse for every inch. Power doubles back through a four-speed box to a differential built into the partitioned crankcase. In engine cutaway above, note inboard-mounted disk brakes mounted on jointed half-shafts to the front wheels.

Rubber reef

How will we get rid of our millions of worn-out tires? Dump them in the ocean, say the Goodyear tire people. Soon they become crusted with barnacles and provide a rubber reef, teeming with millions of gamefish, where once there was barren sandy bottom.

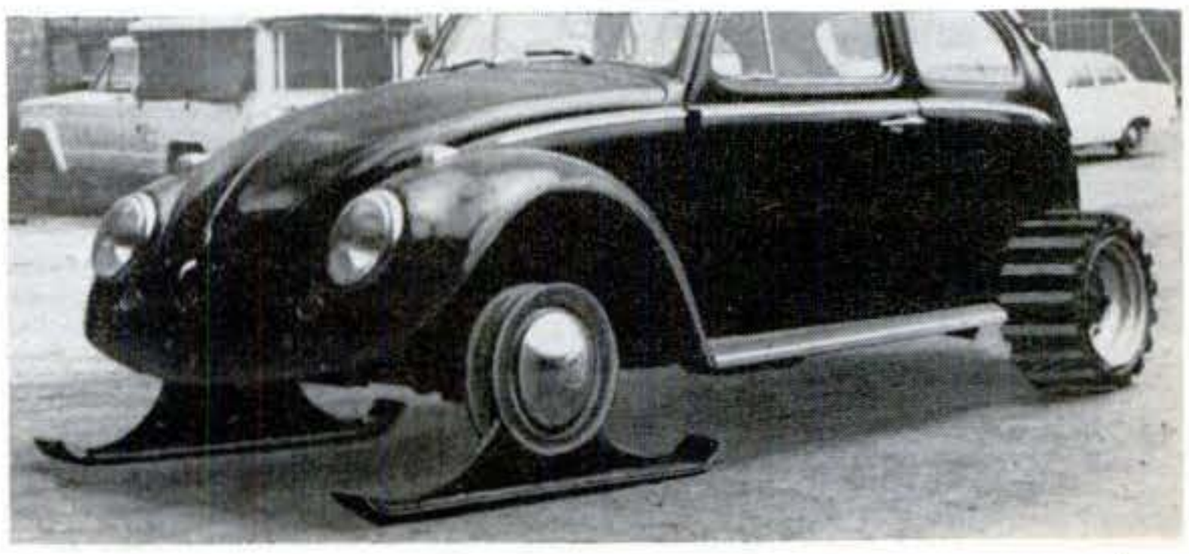
Flexible fan for Vega

The new Chevy Vega will have a new plastic fan. Standard on air-conditioned models, the fan automatically flexes from a high degree of pitch to a low degree as engine speed increases. This gives maximum cooling at low speed and reduces noise and power consumption at high speeds.



Volksmobile

Take a Volkswagen. Replace the front wheels with skis and the rear tires with super-wide cleated types. Result: a four-passenger enclosed snowmobile suited for use in Antarctica. And that's where the South African Dept. of Transport is sending this one.



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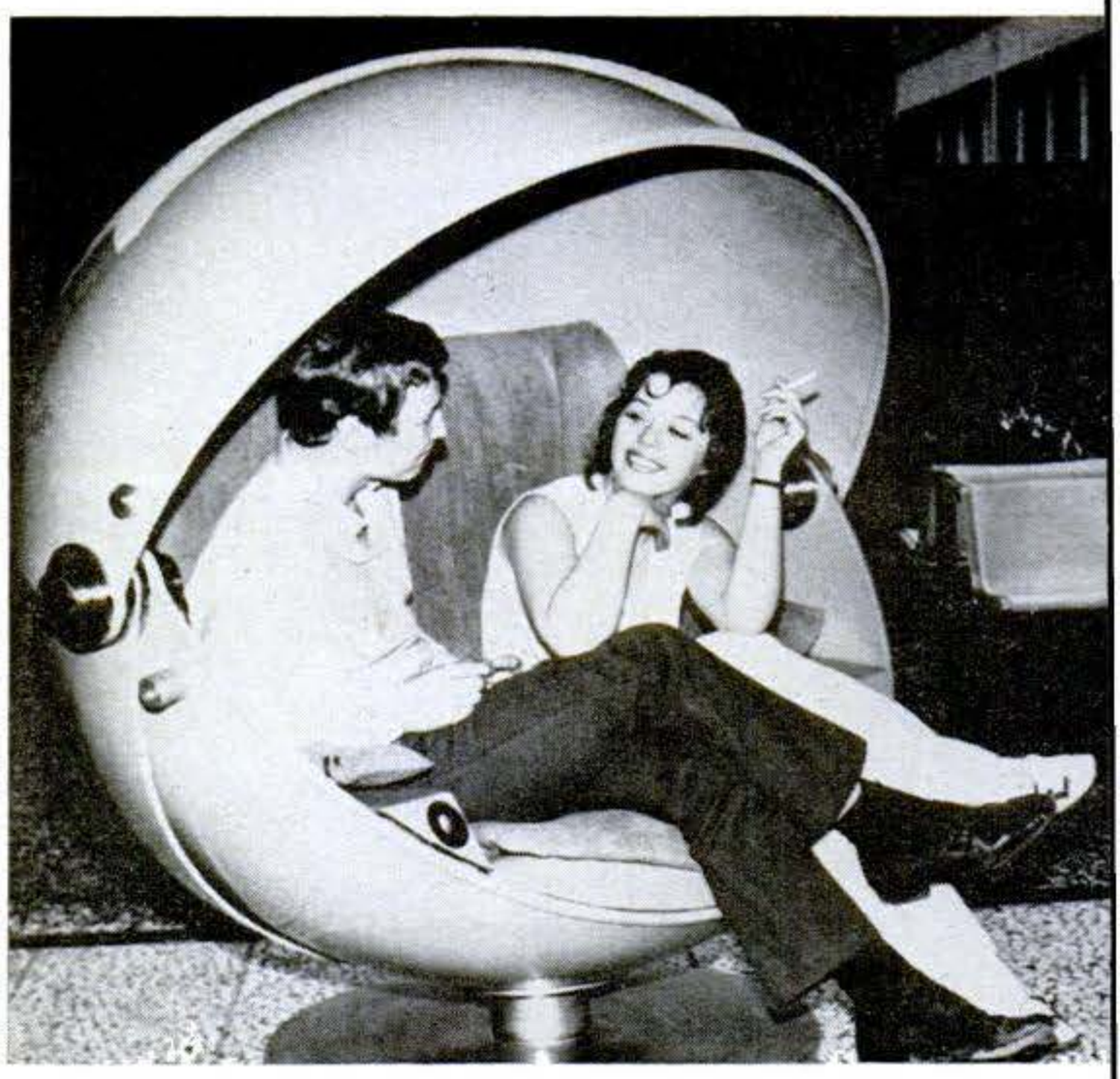
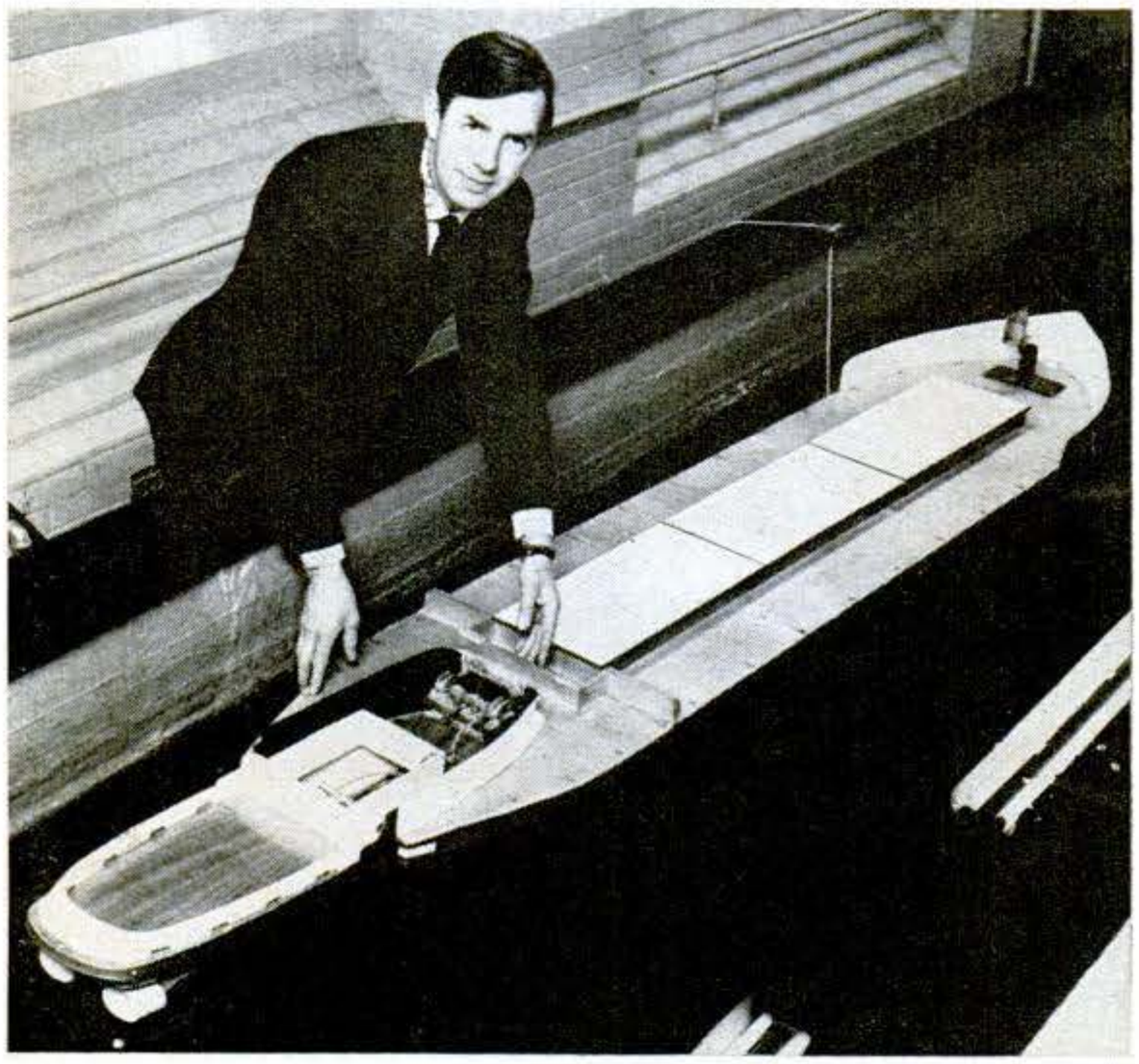
What's New

Luxury clamshell ➔

Slip into this clamshell easy-chair and you can shut out the world. Drop the lid in front, turn on the light, slip a magazine out of the rack, flip on the radio/tape recorder and the ventilator, and pour a drink from the bar. There's even room for a friend. It's made by Rosenthal, a German porcelain and furniture company.



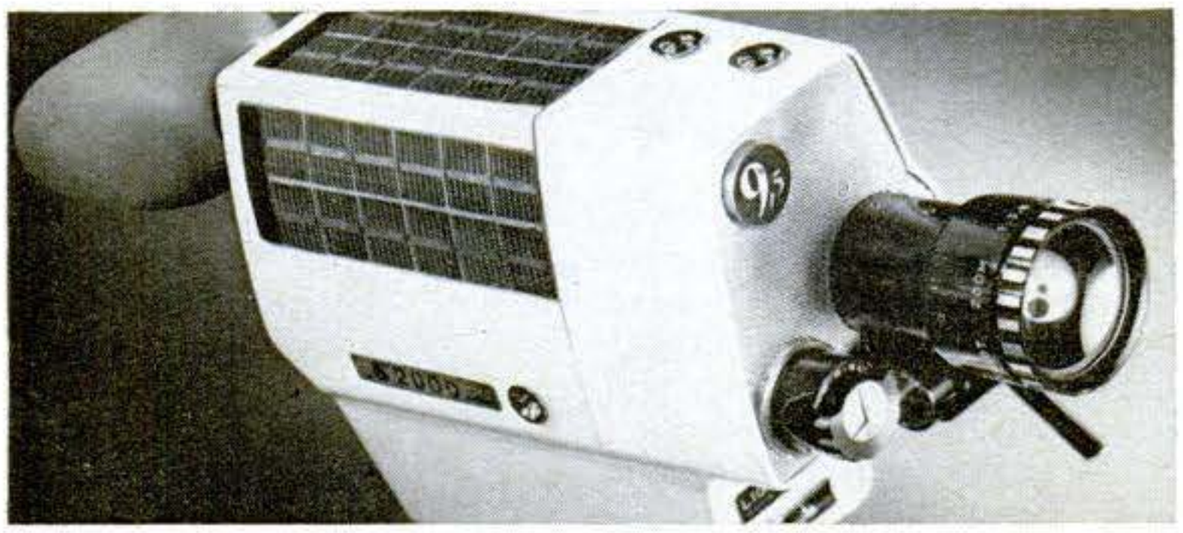


➔ A ship designed to break apart in port

Make two-part ships—half cargo-carrying barge, half detachable propulsion unit—and the propulsion unit can go off on another assignment while the barge is being loaded or unloaded. That's the idea behind the model being tested here. The plan makes the most efficient use of the expensive engine section, and saves money by cutting down on manpower require to crew the ships. The quick-disconnect coupling between units is provided by tongue-and-groove flanges and hydraulic clamps. It was designed at an English school of naval architecture.

➔ Pod-mounted power

Designers mounted the engines on the first German jetliner in pods over the wing. Result? Low fuselage for easy loading and unloading, short and sturdy landing gear ideal for rough runways, reduction of the risk of ground debris being sucked into the engine, and elimination of the break in the landing flaps.



➔ Sun-powered camera

There's no need to plug the new Ligonie S2000 movie camera into the wall to recharge its NiCad battery. Two banks of solar cells do the charging while you shoot. The French camera takes 9.5mm film, so don't look for it in the U.S.

UV flashlight

It looks like an ordinar flashlight, but it's not. puts out a beam of ultraviole light—just the thing fiel technicians need to check fo food spoilage, damage t mechanical equipment, an purity of drugs. Three D cell provide the power. It's $89.5 from PCM Industries, 723 Columbia Pike, Annandale, Va

➔ Latest Triumph

Triumph has replaced the old model 1300 with this new car, the Triumph 1500. It keeps the 1300's front-wheel drive, but the four-cylinder engine has been enlarged to 91 cubic inches and now puts out 61 horses. The new car is seven inches longer overall, but still rides on the same 96-inch wheelbase.

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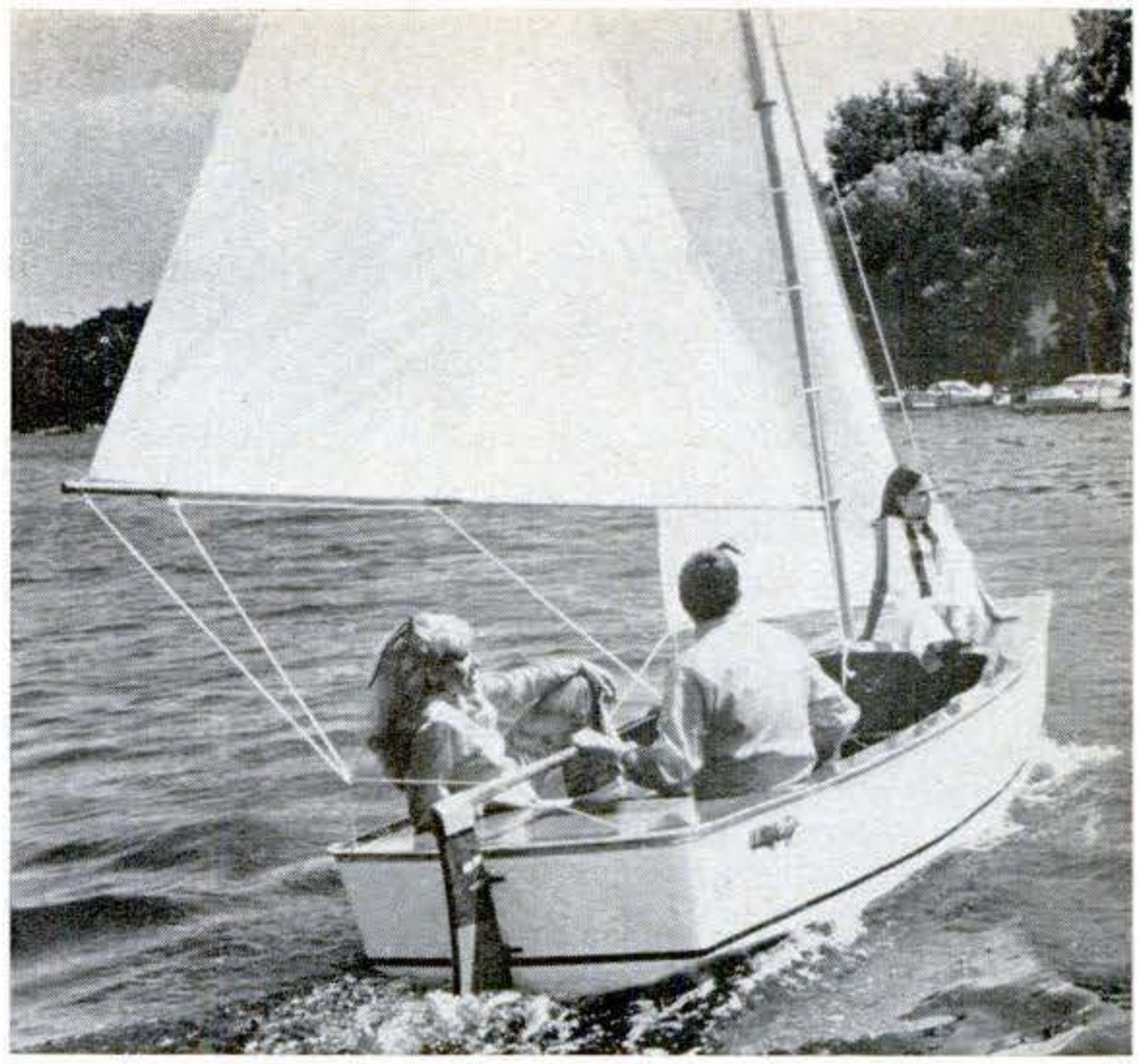
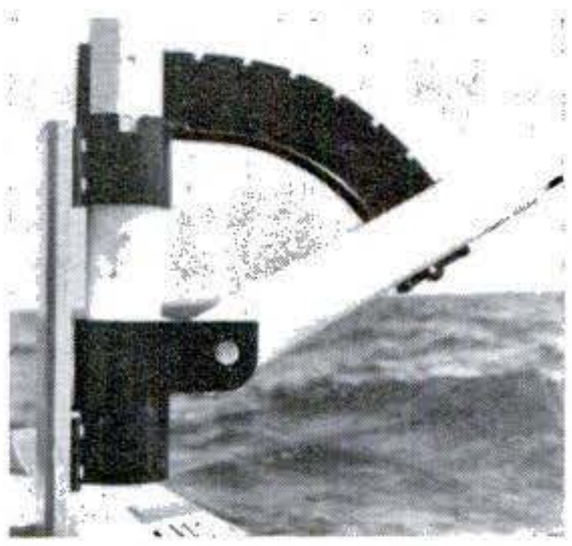
What's New
IN BOATING

Family fun afloat ➔
Looking for a low-cost sailboat big enough for you, your wife, and four kids? Aluma Craft's S-14 is a fiberglass 14-footer with a cockpit as big as those on most 16-footers, and she's priced at $849 with sail. A modified catamaran bow and wide beam make for her family-sized capacity—and stability, too.

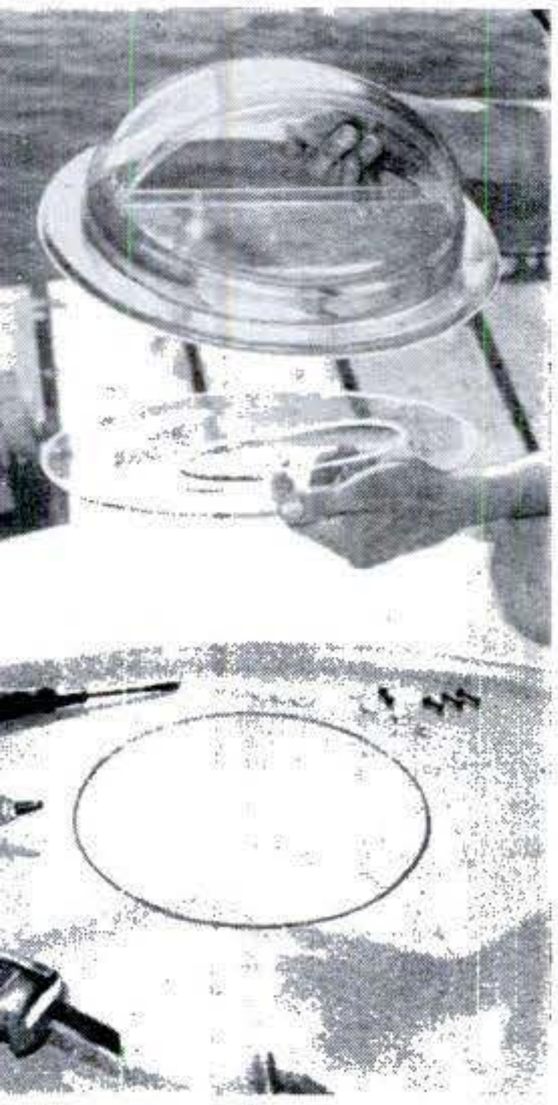


Breath of life
Mount the Life/Breather in your boat or near the pool and you'll be ready to provide artificial respiration if the need arises. A plastic bellows forces air into the victim's lungs; a built-in timed return starts a steady breathing pattern. General Medical Devices, 1559 West 134th St., Gardena, Calif. 90249.

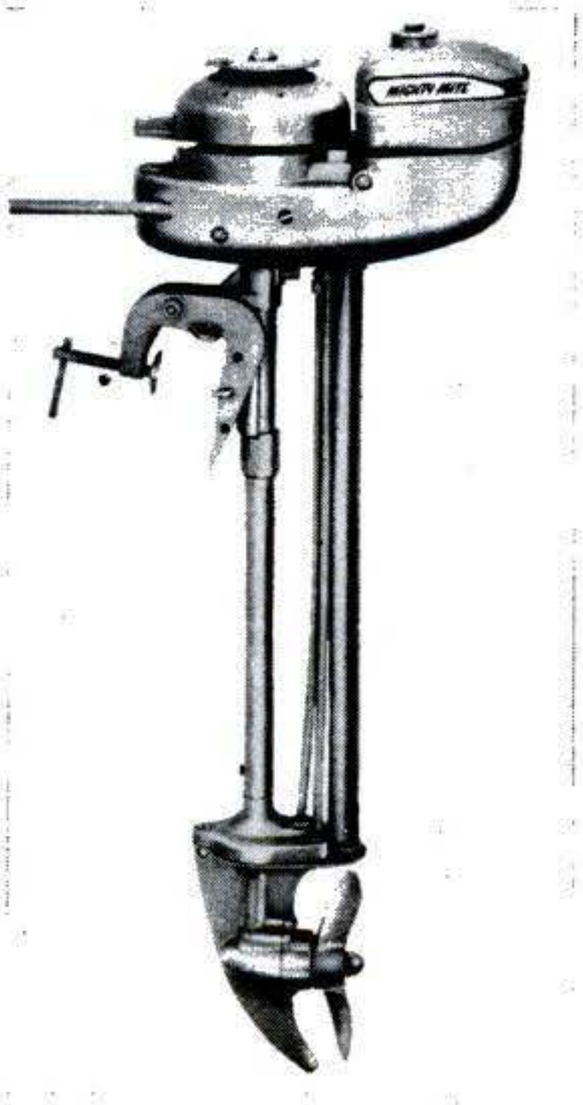


Seven-angle angler
Seven click stops on the curved bracket of this trolling outrigger let you adjust rod angle from vertical to almost horizontal. Plastic and stainless-steel construction give rustfree service on fresh or salt water. A pair of Trolling Pal outriggers is $49.50 from DeWitt Plastics, Box 4000, Auburn, N.Y. 13201.

Seven calls for help ➔
This tiny launcher, only a little bigger than a fountain pen, comes with a kit of seven flares, and can fire them 400 feet in the air for visibility up to 15 miles. The Navy- and Coast Guard-approved kit is $11.95 from Maxim Marine, 2431 Frankford Ave., Philadelphia, Pa. 19125.



Boat bubble
Make a deck vent out of clear plastic and it doubles as a skylight—cheering a bow compartment with sun as well as fresh air. The Sky-Vent, by Sudbury Laboratory, Sudbury, Mass., comes in three sizes: 9, 12, and 15 inches, for $42.75, $71.25, and $99.95. All are easy to install, says the maker.



Tiny troller
Just the thing for trollers, this 17-pound motor packs 1.7 hp, using a chainsaw-type diaphragm carburetor. The carb works in any position. Result: smooth running with the motor tipped to clear a weed bed or shallows. The Mitey Mite is by Muncie Gear Works, Inc., Cordele, Ga. 31015.

Foot-operated outboard
A foot pedal handles starting, stopping, shifting, steering, and speed control on this electric outboard, so your hands are free to fish. Power for up to two days of fishing comes from a 12-volt car battery. The Electra Pal Barracuda 84A is by Osborn Engineering, 1400 E. Lafayette St., Bloomington, Ill. 61701.

Fisherman's easy chair
Rod holder, beverage holder, and tackle box—all you need for a lazy day of fishing is built into this tubular-steel chair. Back at camp you can remove holders and tackle box, slip off the backrest, and it's a handy camp stool. The 3-in-1 Sports Chair is from Elmco Specialties, Box 864, Des Moines, Iowa 50304.

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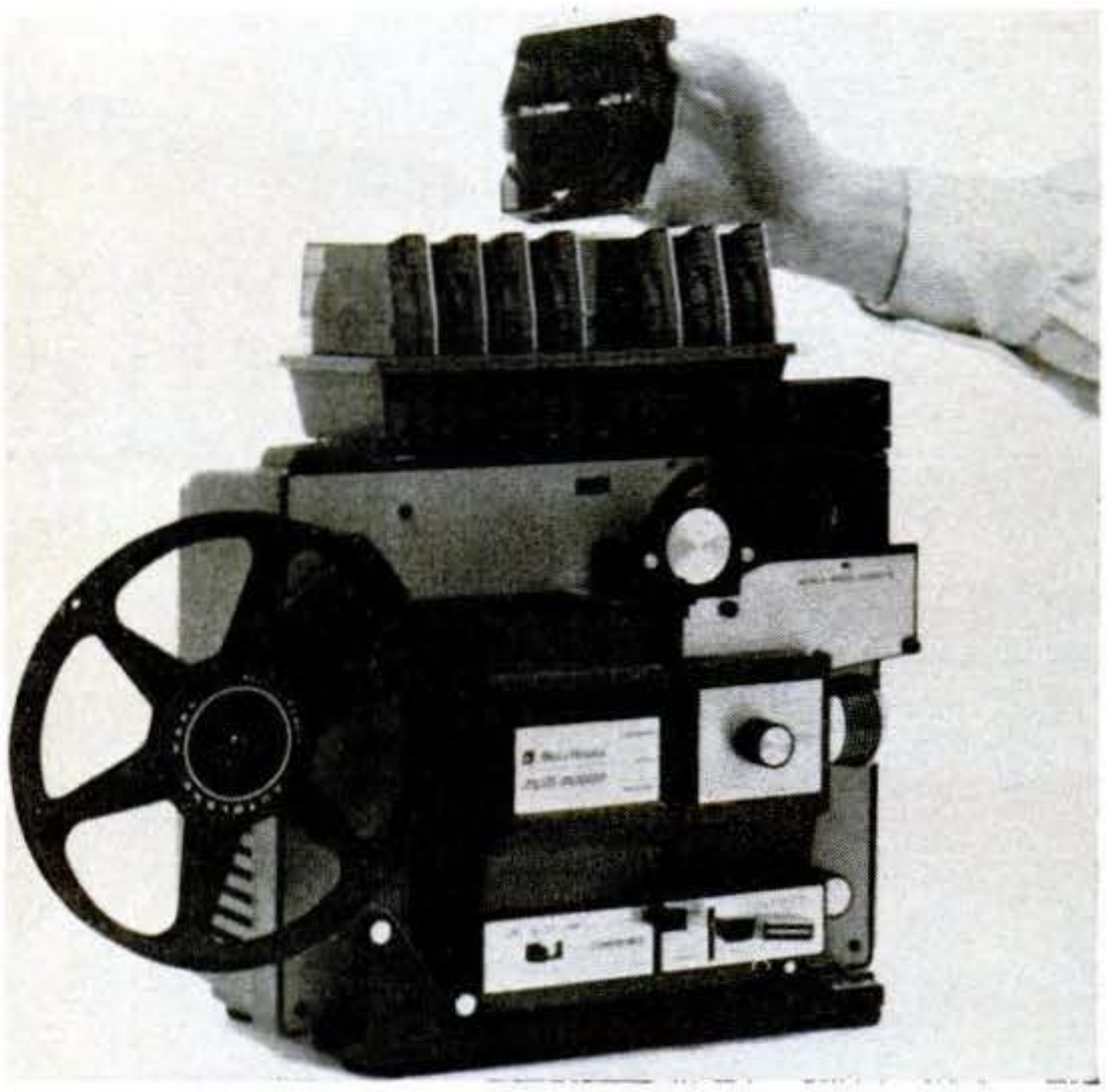
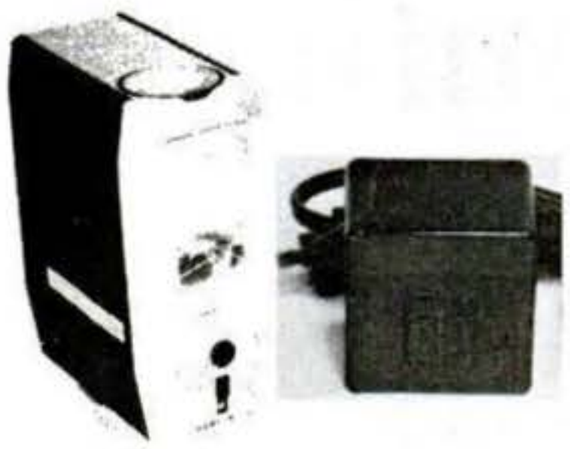
What's New IN PHOTOGRAPHY

Fumble-free film ➤
Sit back and enjoy the show—there's no threading or rewinding with Kodak's new Instamatic M110 projector. You just drop in a cartridge—up to 400 feet— and the projector takes over from there. At the end of the cartridge the film rewinds automatically—as fast as 90 seconds for 400 feet.

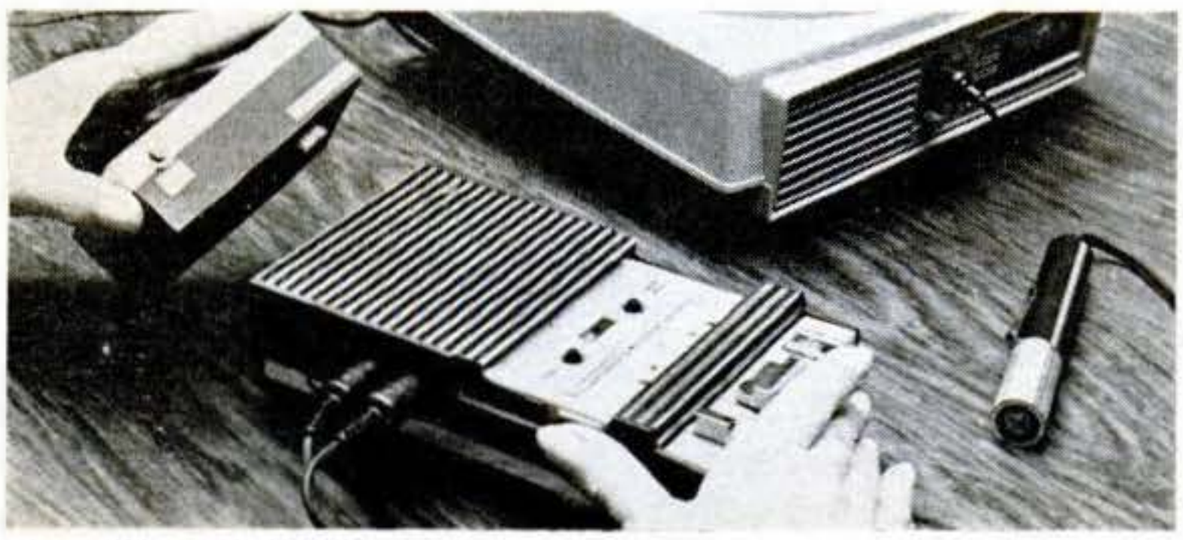


◄ Cassette projector
Bell & Howell has a new projector, too: It handles regular 8 and super 8 film in 50-, 100-, 200-, and 400-foot cassettes. You never touch the film; the projector runs it and rewinds it. Prices start at $159.95. Cassettes range from 65 cents for the 50-footer to $3 for the 400-foot size.



◄ Rapid rebound
Automatic exposure control and a new quick-charge feature make the Honeywell Auto-Strobonar 332 an interesting addition to the strobe market. A 20-minute charge on a set of dead batteries gives you enough power to rap off 30 shots. In a real hurry? Five minutes gets you 10. Price? $99.50.

Two little brothers ▲
That slick little Rollei 35 is one of two new money-saving models. The 35B (pictured above) offers a non-coupled selenium meter instead of a CdS meter. A 35C model comes without meter. Both have 40mm f/3.5 Triotar lenses instead of the 35's Tessar. The 35B sells for $159.50; the 35C, $139.50.



◄ Slide syncher
The Mentor MK IV will synch *any* tape recorder—monaural or stereo—to your slide projector. An inaudible cue on the same track as your narration automatically triggers a slide change. Two models are available, $50 and $80, from Saunders Associates, 297 Danbury Rd., Wilton, Conn. 06897.

What's Ne IN ELECTRONIC

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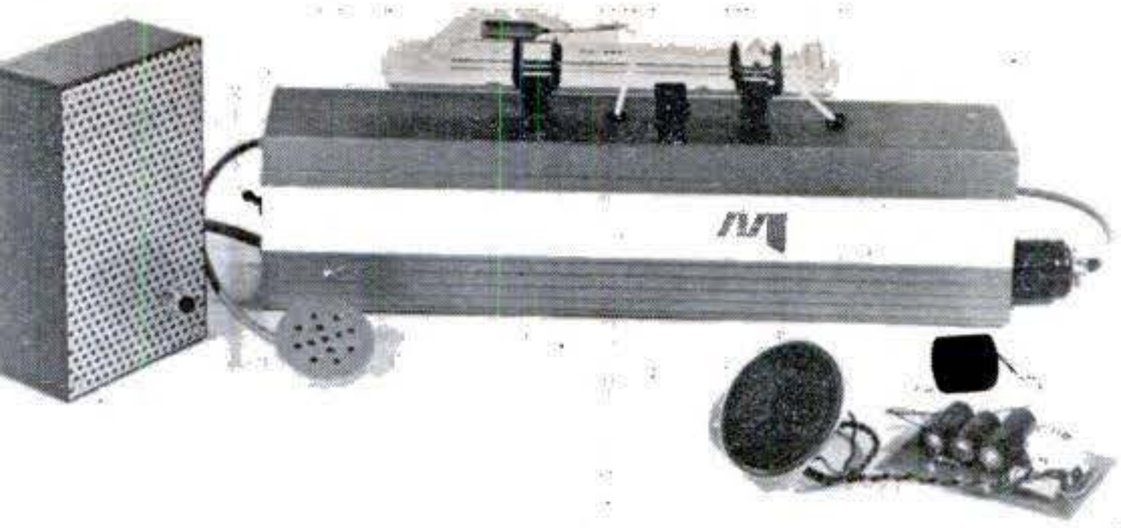
What's New FOR YOUR CAR



Compact entertainment

is seven-pound, 9½-inch-gh package puts TV, AM/FM dio, and a cassette tape stem into your car, boat, fice, or tent. It runs on tteries or AC (or, with an lapter, on your car battery), d comes with mike, AC lapter, and earphone r $229.95. It's the mphonic Mini-Max.

▲ Laser communicator

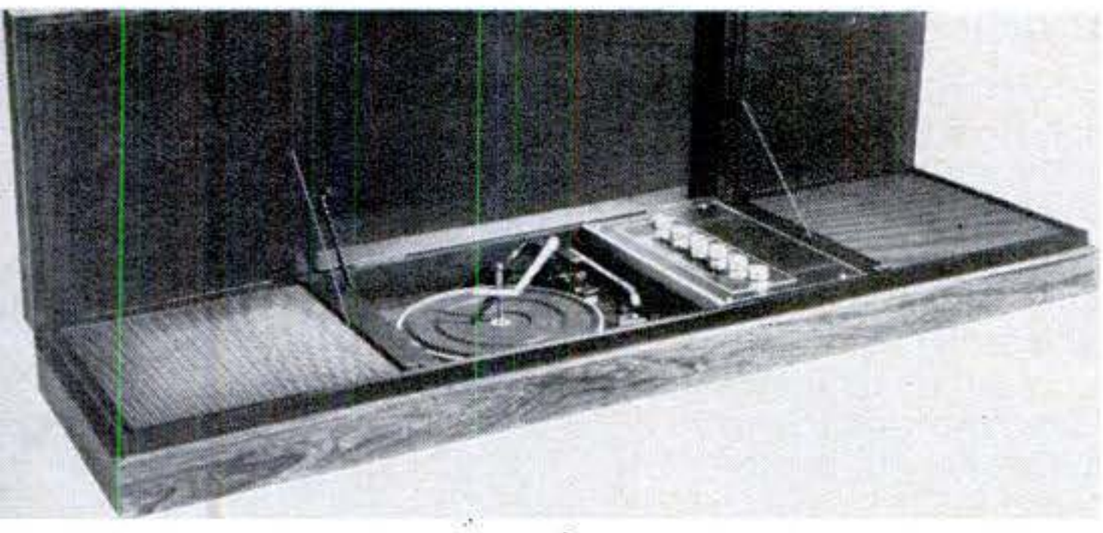
It's sort of a walkie-talkie that transmits over a laser beam. You can get it for under $150 in kit form or $200 fully assembled. Features? It can transmit voice, video, or data signals; it's jamproof, efficient, and unaffected by radio noise. Metrologic Instruments, 143 Harding Ave., Bellmawr, N.J. 08030.

Ray meter

you ever want to check a icrowave oven for energy aks, here's a tool to use. e antenna on top picks the stray rays and ives the gauge below. e Microdek Model 310 is 5, from International ystal Mfg., 10 N. Lee, Okla-ma City, Okla. 73102.

▲ Bedside companion

Digital AM/FM clock-radios are the latest thing from Japan. And this Hitachi Digi-Brite is the latest thing in digital clock-radios. Its numerals are on continuous bands—no flip-flop mechanism. It sells for $70.



X-ray warning

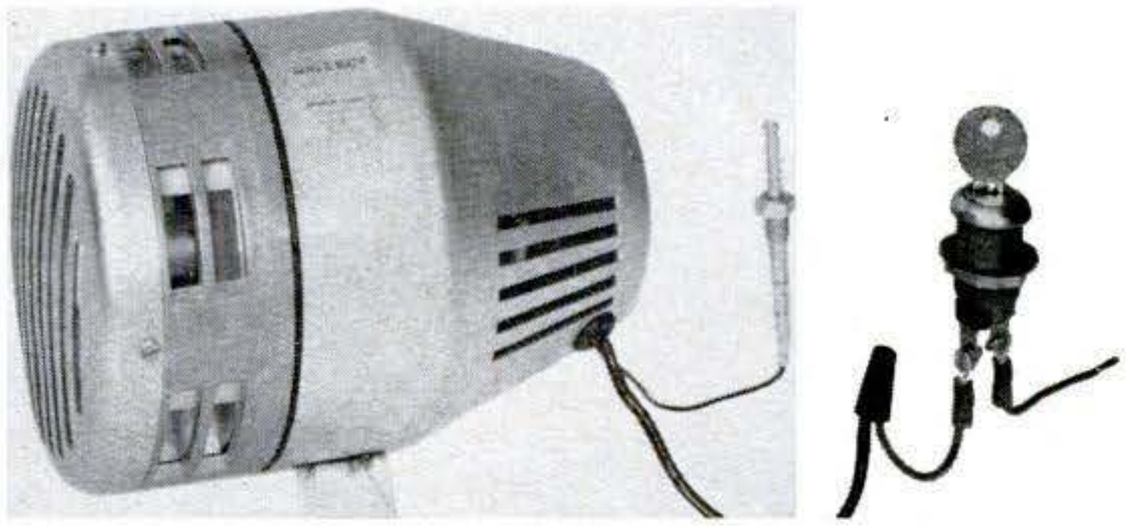
l those warnings about rays from color TV got you rvous? A Rayguard will onitor your set's high-ltage parts. If voltage ceeds design levels (that's hat causes the radiation) e meter will tell you. ayguard must be installed a TV repairman. It's made Walter Kidde & Co.

▲ Skinny stereo

A mere nine inches high, but over four feet long—that's the new thin-profile stereo by Teledyne Packard. You mount it on a stand or shelf and plug it in. It offers AM/FM radio, or music from your favorite records—soft with the hinged speaker covers closed, louder with the covers swung open.

Auto alarm

An alarm that detects thieves by current flow? Right. If the would-be thief opens your car door (dome light goes on), turns on the lights, steps on the brake, or turns on the ignition, he'll trigger a wailing siren. The Cyclone Sens-O-Matic is $39.95, from Monroe Timer Co., 625 Soundview Ave., Bronx, N.Y. 10472.↓

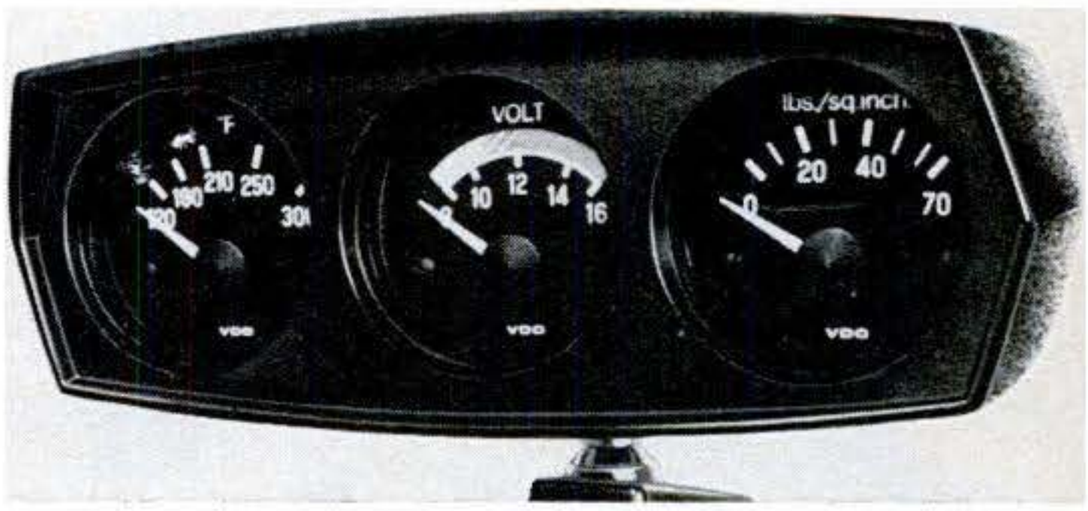


Shoe saver ▲

You'll never drive off in your VW with the hand brake on if you install this alarm. It rings a bell if your brake is on and the car is in motion. Fits other imported cars with tunnel-mounted brake handles, too. It's $7 from J.C. Whitney, 1917 Archer Ave., Chicago, Ill. 60616.

Concentrated juice ▲

Thin plastic walls in the Juice Box (rather than hard rubber) leave room for more plates, more acid. The result: 75 percent more cranking power for those big-inch muscle cars. The new battery from ESB can deliver 530 amps, has an amp-hour rating as high as 95. Outside dimensions are standard.



A mount-anywhere instrument cluster ▲

Looking for something better than idiot lights to keep you informed on the situation under your hood? The Mini Cockpit's a nice solution. It combines a temperature gauge (water or oil); voltmeter, to show battery condition; and an oil-pressure gauge. The unit mounts above or below the dash and hooks quickly into your electrical system with five wires. An accessory bracket lets you mount the module on your steering column. The Mini Cockpit is made by VDO Instruments, 116 Victor St., Detroit, Mich. 48203.

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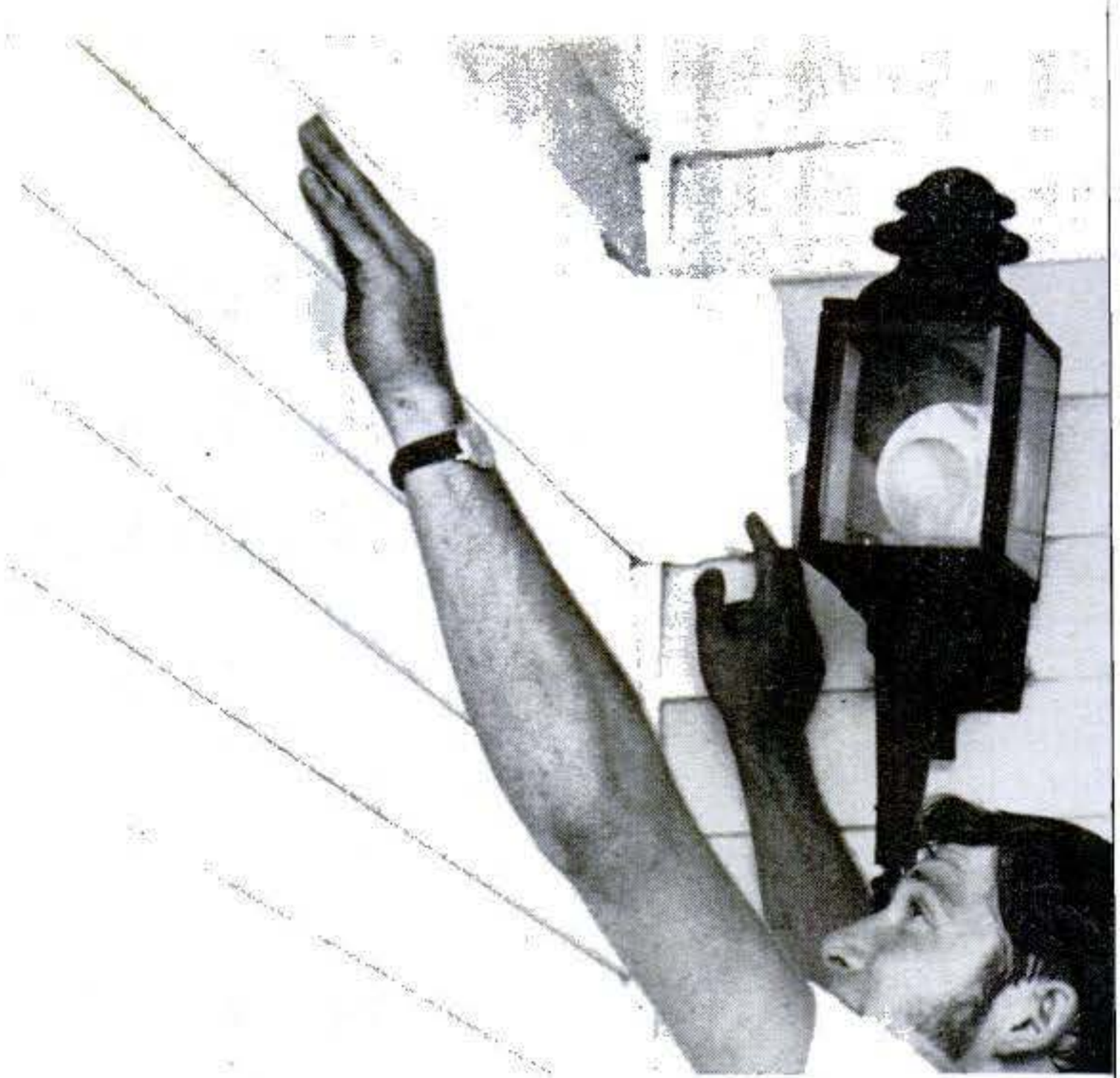
What's New IN HOME IMPROVEMENT

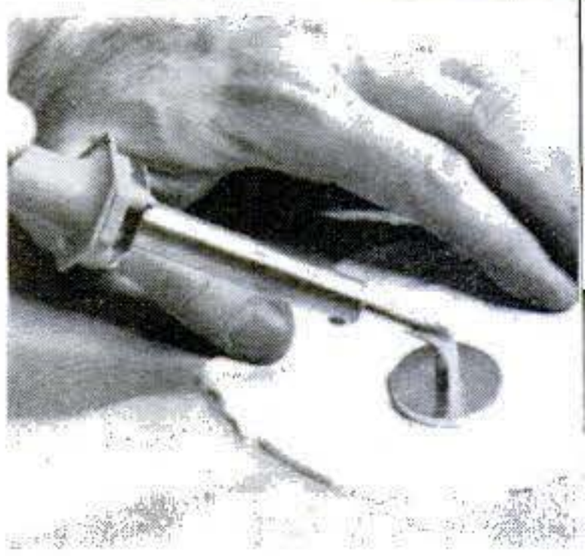
Finish goes on like tape ➤

House painting may become obsolete. Now you can coat wood siding with self-adhesive vinyl film that's impregnated with white pigment. Morgan Adhesives of 4560 Darrow Rd., Stow, Ohio, calls it MAClar; claims it takes weathering better than paint, lasts for 10 years. It comes in rolls 27 in. wide, 50 yds. long.



Weld a patch on vinyl ➤

When vinyl fabric is torn or burned, you can patch it by spreading on a paste called Vyna-Weld. A texturing mold, created from the surrounding surface, is heat-pressed into the patch with special tool. Repair matches grain and color. Vyna-Chem, Bound Brook, N.J.



➤ Lightweight stone wall

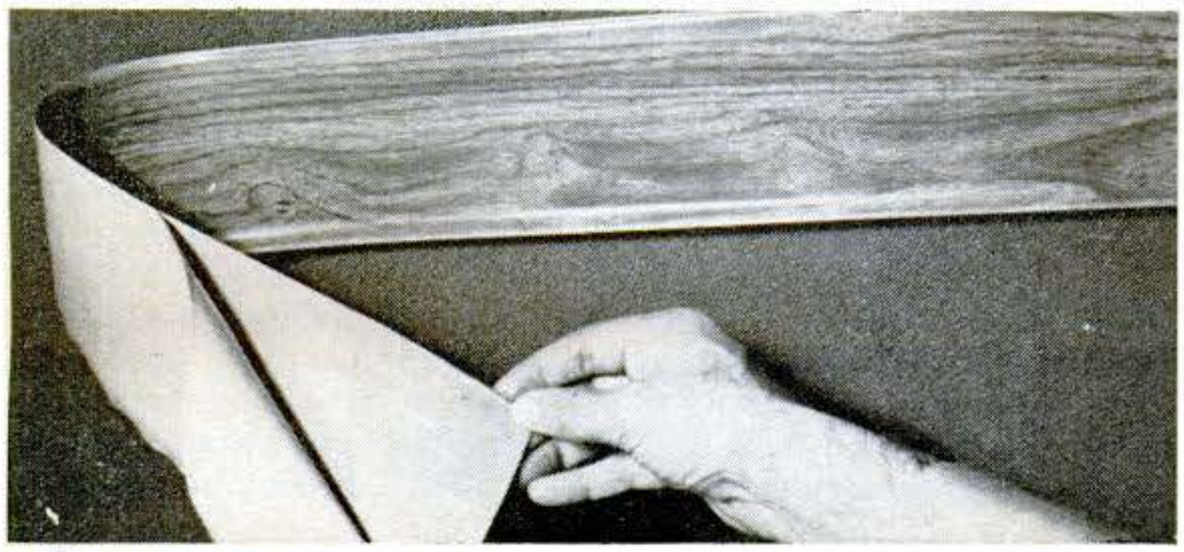
You needn't be a mason to remodel your den or patio with natural stone. A unique volcanic rock—one-fifth the weight of granite—comes bonded to hardboard in modular (36"-by-48") panels. Face can be rough, as shown, or smooth-sawed. For closest retailer, write Featherock, 6331 Hollywood Blvd., Los Angeles 90028.

➤ Cable-drive door opener

Here's an automatic garage-door system you can tote home from the store, install without help in a couple of hours. Pow-R-Lift has a simple cable to replace noisy drive chains. Press a button on the handset in your car: the unit opens the door, turns on the light. By Relaytron, Mt. Vernon, N.Y. Under $180.

➤ Self-stick cove base

It installs several times faster than regular spread-the-glue types, and Nafco's Quik Stick Cove eliminates cleanup, as well. It comes in various colors and wood grains. The new peel-and-stick adhesive is guaranteed to hold. National Floor, Box 354, Florence, Ala.



Lamp travels with you ▲

This tiny adjustable lamp plugs into any outlet and swivels to throw light wherever it's needed. Tuck it in a suitcase to assure good reading light in motels. Or use it at home to spotlight art. Or as a worklight in your shop. It's made, with either two- or three-prong plug, by Swivelier, Nanuet, N.Y. 10954.

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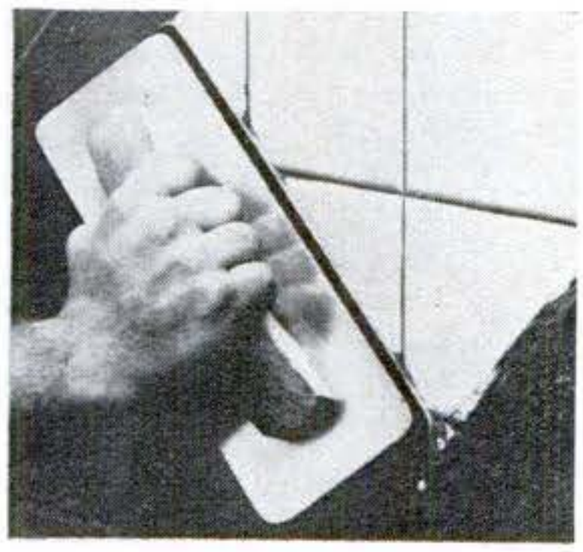
What's New
IN TOOLS

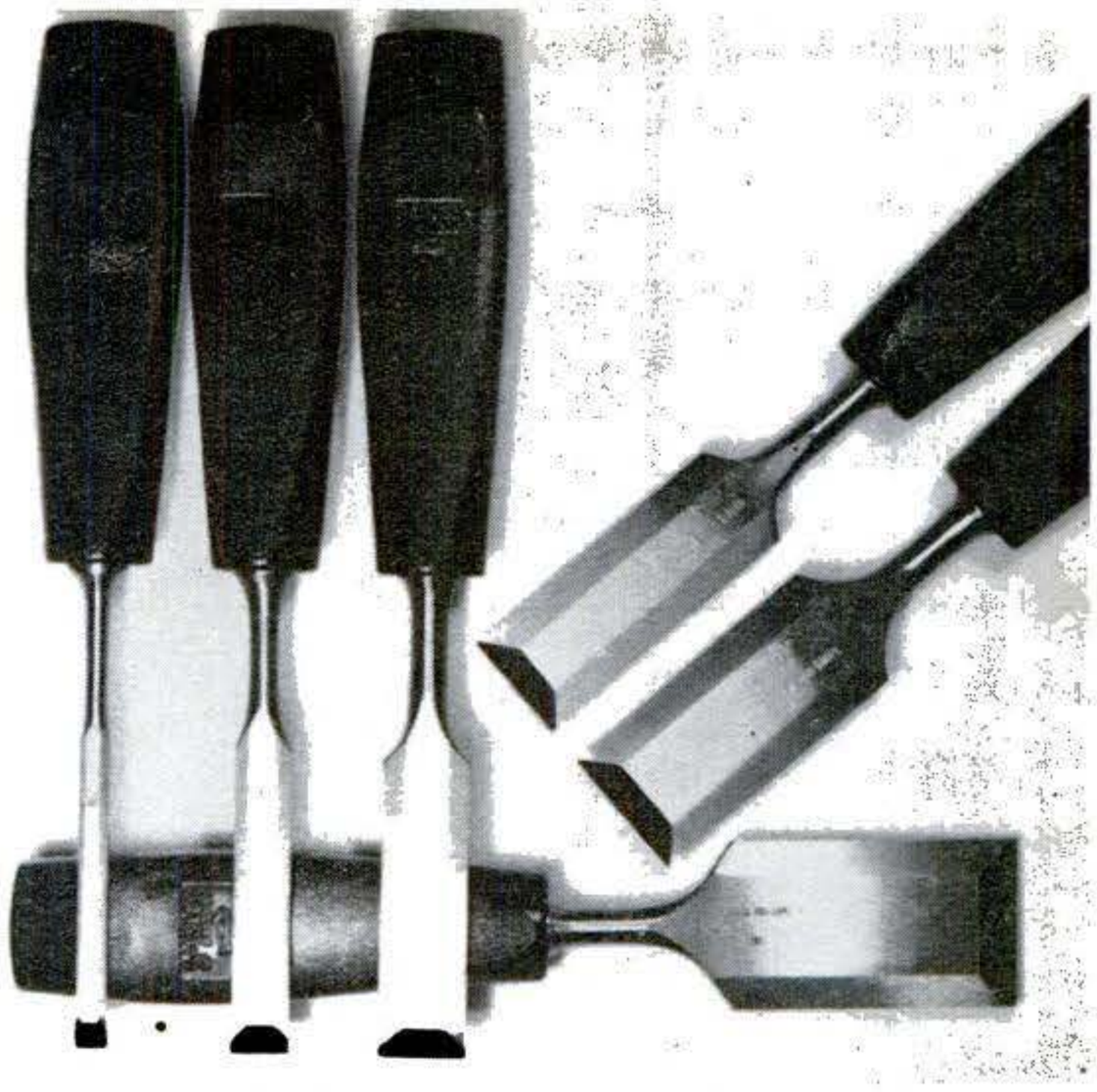
Easy shingle corners

e chore of trimming and ing individual shingle and ake cou-ses at the corner a mansard roof is eliminated en you use factory-as- mbled corners from Shaker- vn Corp., 4416 Lee Rd., eveland 44128. Just over at the butt line by 17" in gth, they're mitered and bered to ensure a true fit.



Rubber-faced trowel ▲

Grouting ceramic tile, slate, flagstone, and brick is faster —and takes less grout—with the K-R Groutmaster trowel. Flexible rubber facing compresses the grout into the joint while acting as a squeegee on masonry surface. It's made by American Olean Tile Co., Lansdale, Pa. 19446, has an easy-grip handle.

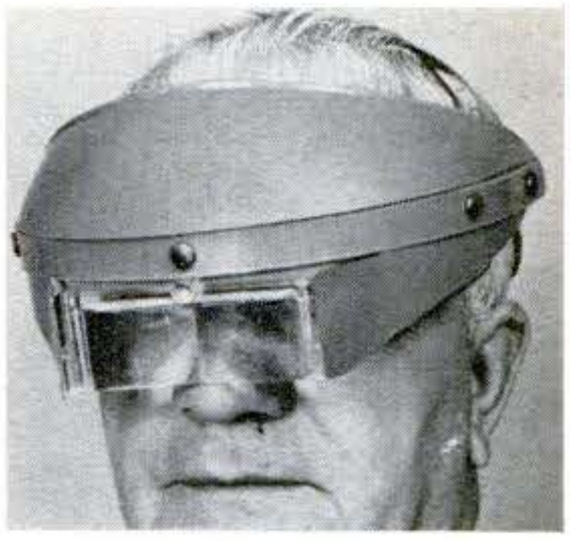


Things like chisels never change—right? Look again ▲

Sandvik Steel is catching attention in hardware stores now with a whole new line of chisels. The Swedish tool-steel blades feature correct hardness for a tough, lasting edge, a full-bevel pattern for fast, efficient work, and a rustproof plastic coating. They come in the six popular widths: ¼", ½", ¾", 1", 1¼", and 1½". Handles are identical on all sizes—a new flat shape for comfortable grip and position control. And this design keeps the chisels from rolling.

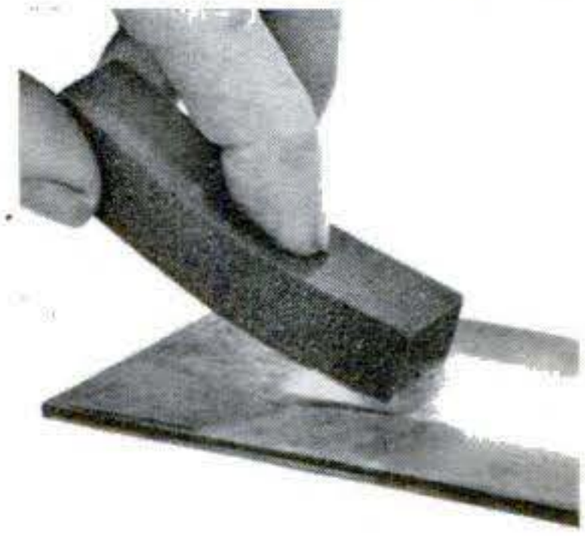
Down with the squints ➤

If you do close work, treat yourself to Bausch & Lomb's Magna-Visor. It boasts the largest field of view of any headband magnifier, eliminates the center post and offers three interchangeable lenses—1½x, 2¼x, 3½x. Write: 635 St. Paul St., Rochester, N.Y.



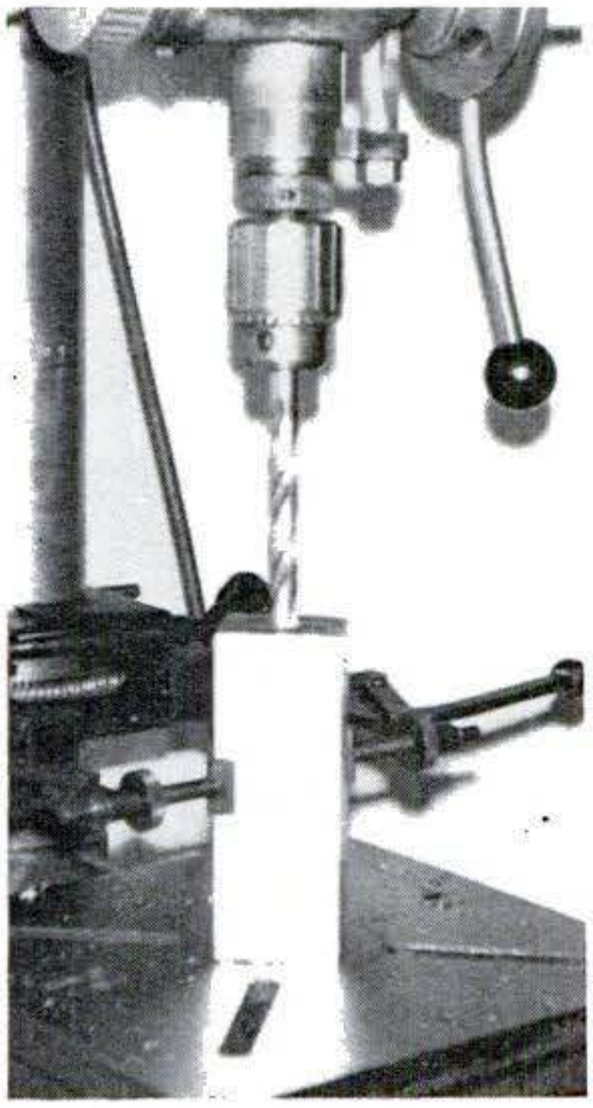
Rub out that rust ➤

This finger-sized abrasive bar helps you clean and restore hardware and metal trim on boats and cars. Its fine grit leaves a satin finish after removing rust and corrosion. Rust-Eraser is made by Coricone Corp., 3605 Long Beach Blvd., Long Beach, Calif.



Portable purifier

ached to any faucet, the motic purifier can produce gallons of fresh water in hours by removing mineral ts, chemicals, impurities. ly 11" deep and 16" high, an be set on a sink counter hung on the wall. From viron, Costa Mesa, Calif.

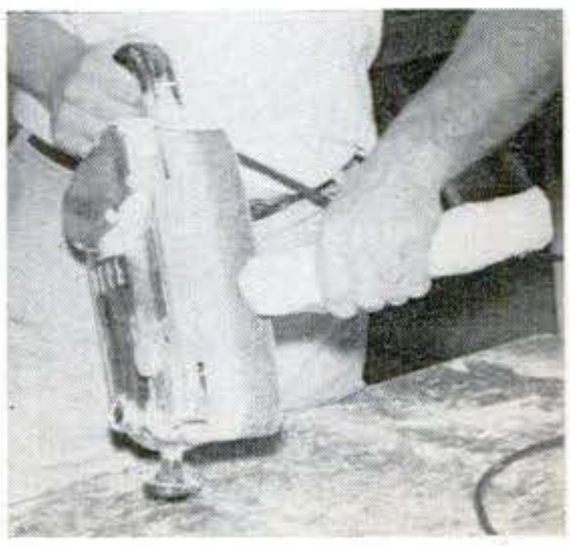


Get a grip on things ▲

An attachment for any drill press with a 2¾" column, the Fas-Set extends double arms that adjust for either horizontal or vertical holding. Above, arms have V-holders to position square or round work upright. Accessories adapt to other shapes. It's $39.95 from G. Manville, 35520 Oak Glen Rd., Yucaipa, Calif.

Longer sandpaper life ➤

Hold a Dandi-Bar against the belt while you run your sander and it will clear the grit of wood dust, extending belt life 60 percent. On smaller machines, just rub it against the abrasive. It's $6.95 ppd. from Ken Acker, 3314 W. Loomis Rd., Greenfield, Wis. 53221.



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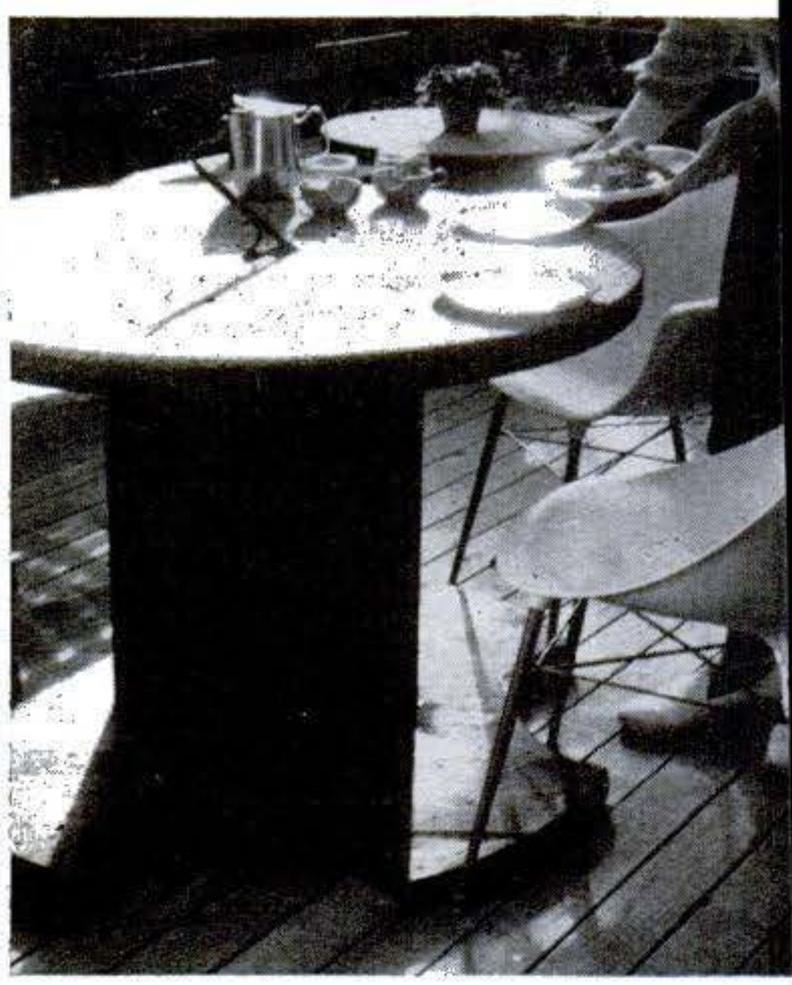


With four bites from the bottom, a coat of black stain, and a colorful top, discarded reel becomes an outdoor dining table.

Two ways to make center hole an asset, at left: cover with brass sundial cemented down; slip in vase of flowers or plant.

When the item is free, you can afford to top it with a colorful, lasting epoxy

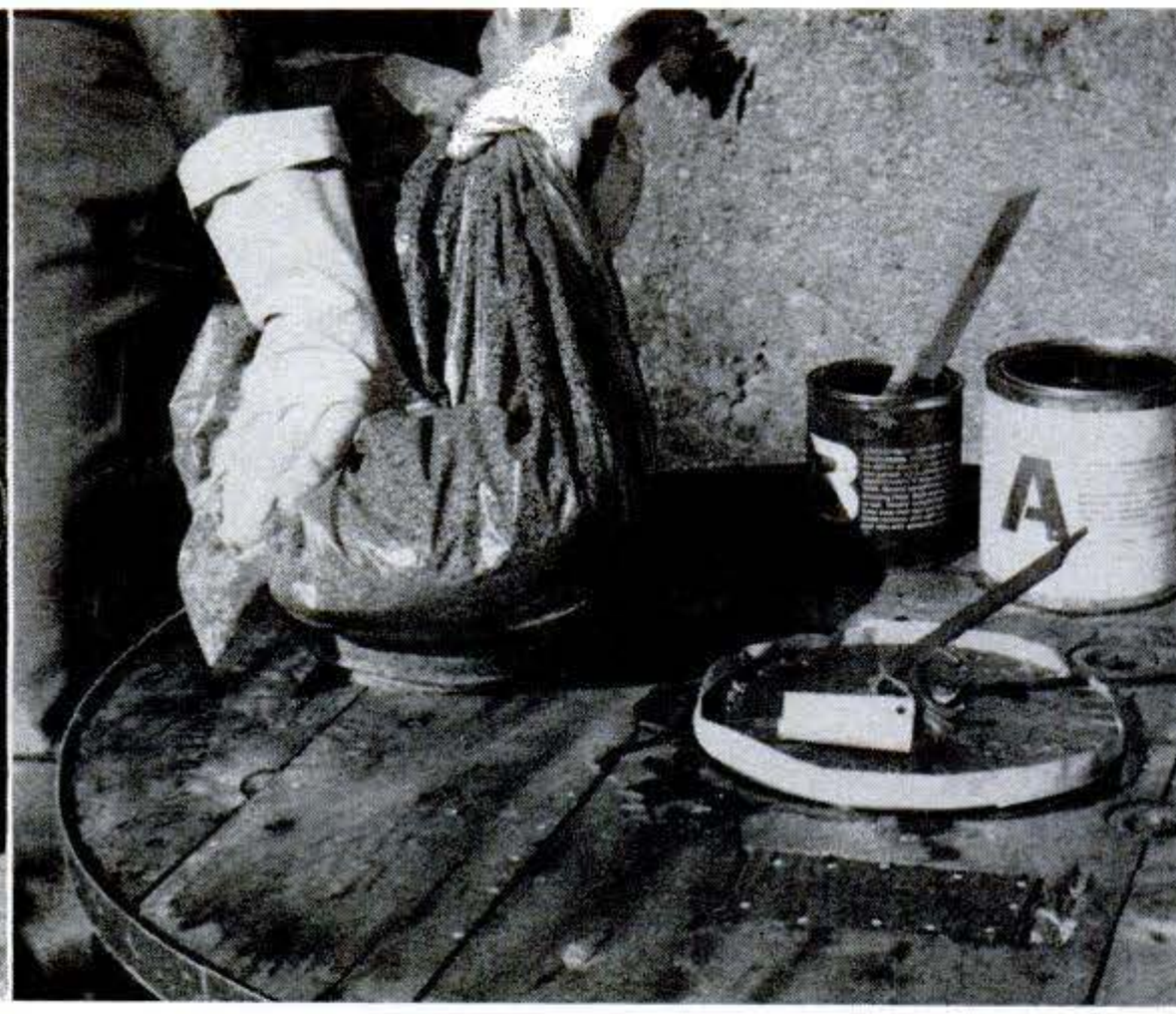
By DARRELL HUFF

Some people call them hippie tables because they're about all the non-sleeping furnishings you'll find in many a pad. No wonder: They're useful, sturdy . . . and free.

They are empty cable reels discarded by utility companies. Since these wooden reels—unlike the metal ones sometimes used—are not returnable to the manufacturers, they are commonly given away to the first comer who asks for them.

I was that first comer at the Pacific Gas & Electric Company yard in Monterey, Calif., the other day. I found a good selection available at

3 When's a reel not a reel? When it has been topped with a colorful plastic material that covers it, cracks and all, ready to stand up to outdoor use. This is called Poradek and consists of a two-part epoxy and a plastic bag of colored granules.



4 After mixing the epoxy, you can use it to cement down the sundial and scraps of wood to patch any major holes. Then pour it into the plastic bag and knead the whole mess until the aggregate is uniformly wet. The rim shown is a temporary one.

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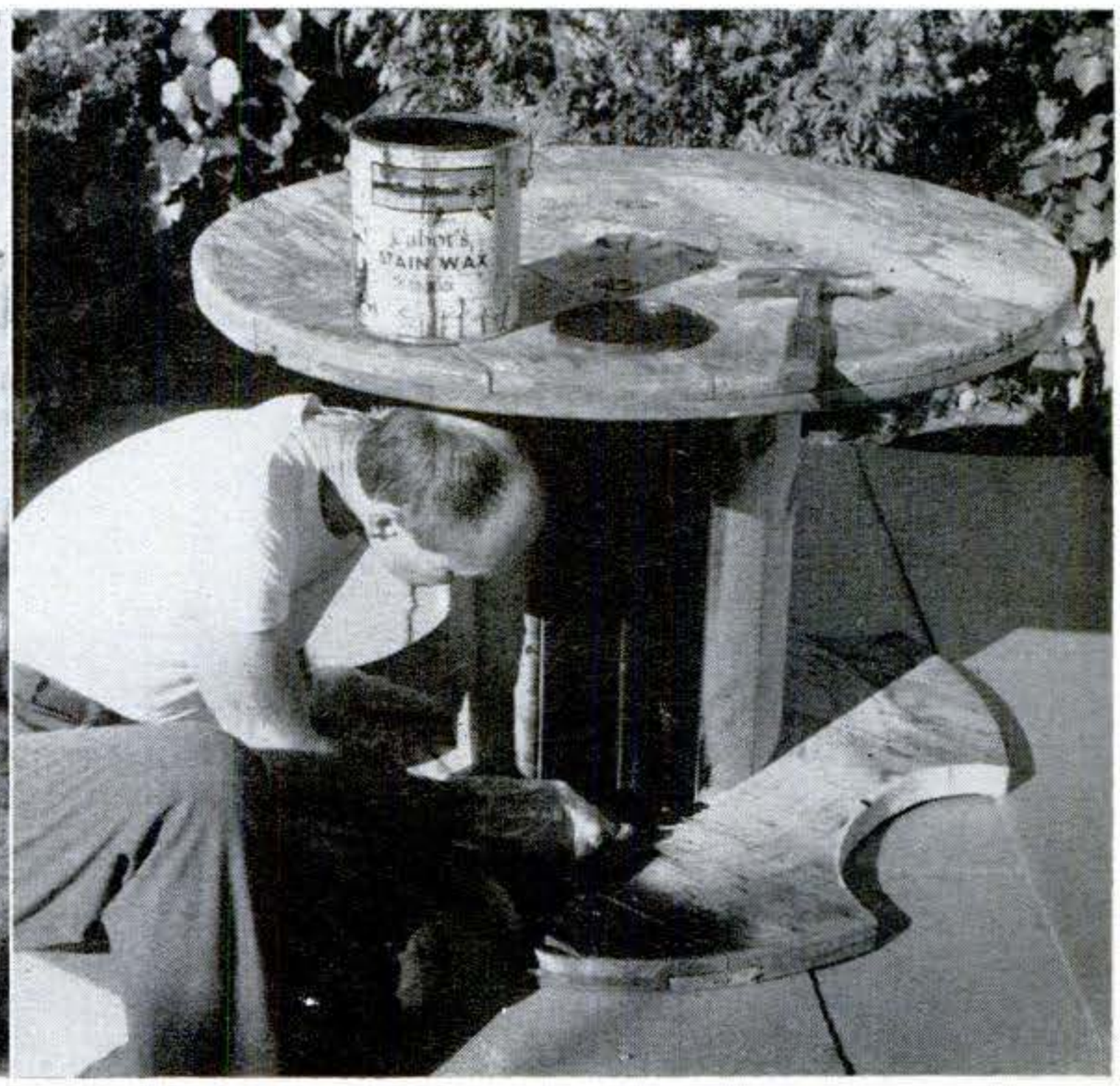
Tables from Cable Reels

1 Only large reel available to author had a chunk knocked out of one flange. He trimmed this gap smooth with a saber saw, and then cut out three other matching bites on the foot.



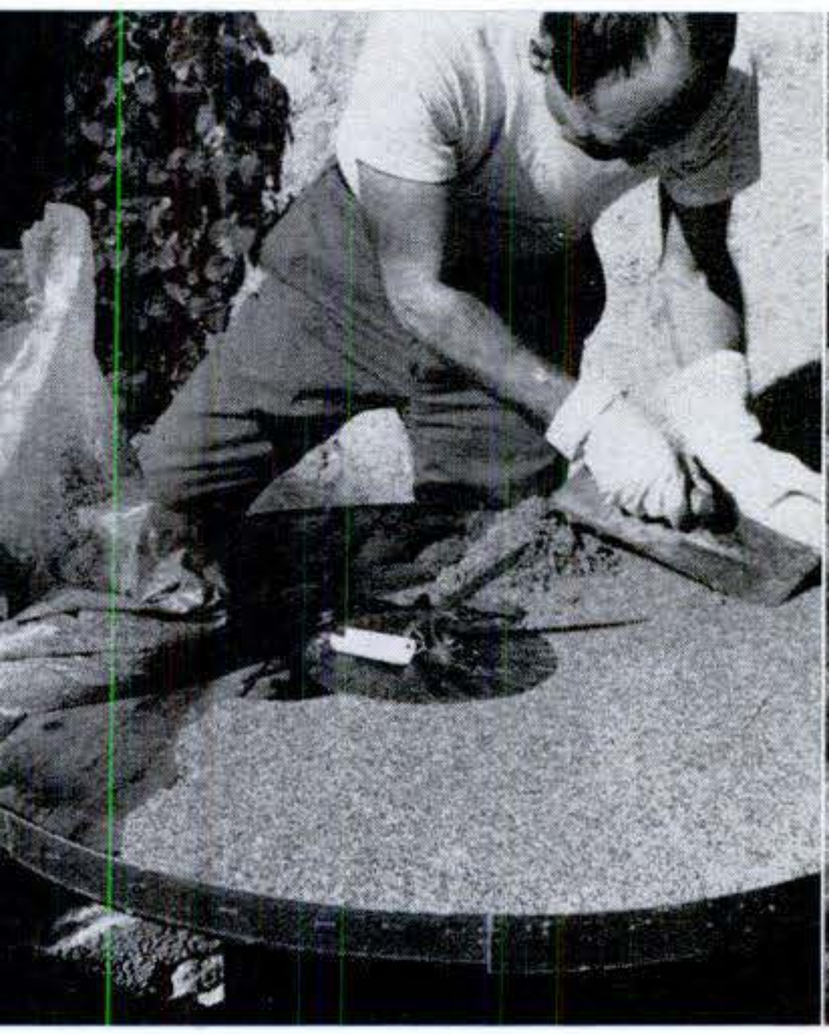
2 A quick and durable finish was provided by wiping on a coat of jet-black stain wax, covering everything but the top surface. For rigidity, tighten bracing bolts that go through reel.

the yard—and picked a pair while I was at it. And astounded the yard foreman by successfully hauling them both off at one time in my tiny VW convertible.

You have a choice of several sizes, but the ones I chose are convenient. The smaller is 27″ in diameter and 22″ high, right in scale for a small patio, and just big enough to hold a vase of flowers in its center opening and provide chairside tray space for casual lunching.

For a dining table you'll prefer a height of 28″ to 30″, which describes my second acquisition. If you regularly feed more than four people outdoors, you might want to see whether your local utility has something available with an even larger diameter than this 40-incher of mine.

For how I turned the reels into handsome outdoor tables, follow the photographs. PS



5 Spread mixture with trowel. A temporary rim of Filon plastic stapled on made it easy to get uniform thickness and neat edge. Epoxy won't stick to this plastic.

6 You can get along without an edging on a smaller reel, but you'll work harder and won't get quite so trim a result. The flowerpot smooths the center hole.

7 Poradek comes in 30-sq.-ft. kits in many bright and dull earth colors at $19.95 plus shipping from Resin Systems, Inc., 25-29 50th St., Woodside, N.Y. 11377.

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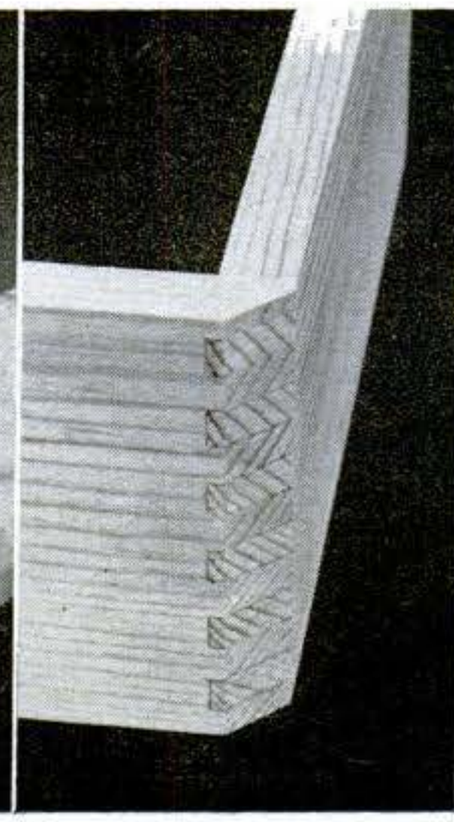
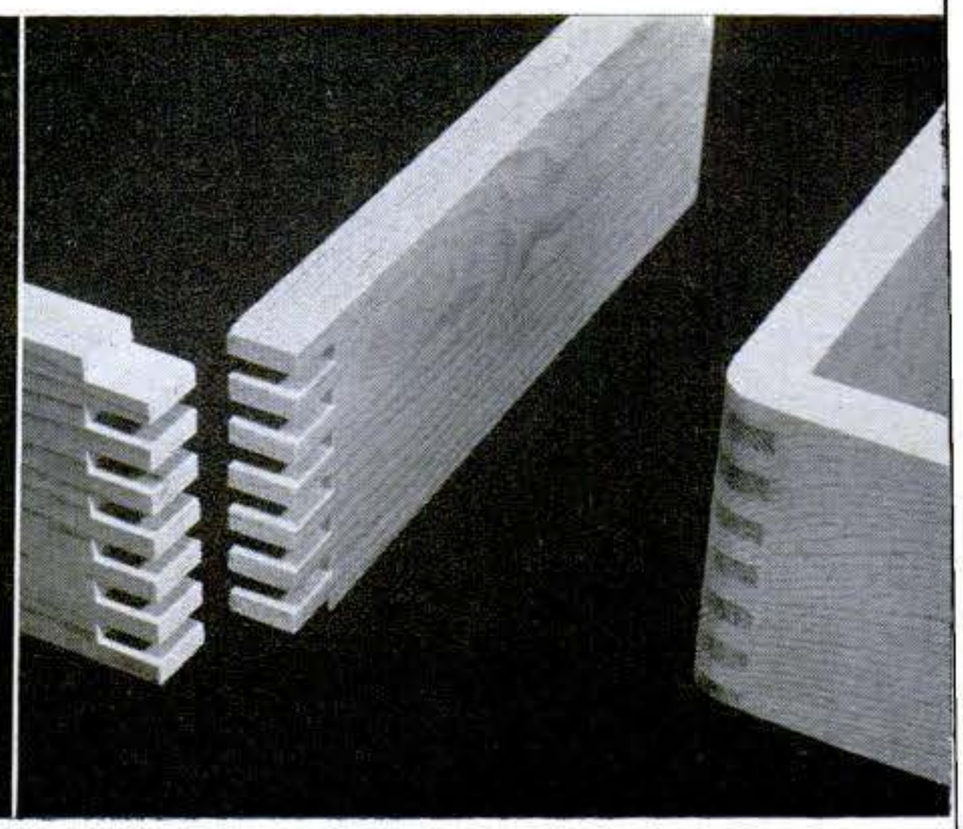
The FINGERLAP JOINT: Symbol





Fingerlap joint takes its name from intertwined human fingers—as you see here. It's often left exposed as a sign of superior work. Above is a joint ready for assembly, and two special treatments—a 45-deg. cut after assembly (center) and sanded round.

By R. J. De CRISTOFORO

Like the dovetail, the fingerlap joint is often found on old classics, exposed in some areas to denote an above-average degree of craftsmanship and used in some hidden places because of its strength.

Its basic design doesn't provide locking. Therefore, glue failure would result in separation. The chance of failure with modern adhesives is pretty remote, however. So it's an excellent joint to know.

Structurally, its appeal lies in an unusual amount of gluing surface—something you can judge quickly by passing the fingers of one hand between the fingers of the other. This strength is recommendation enough for using the joint on moving components like drawers and on frequently-handled items like boxes. You'll find it on jewelry boxes, humidors, and similar items. It's often called a box joint—a term that is somewhat unfair since it connotes only minor applications. Correctly done, it can be left exposed as a commendable piece of work.

With a table saw and the jigs we show, you can turn out fingerlap joints as precisely and quickly as the experts do.

Designing the joint. It is often recommended that the cut width be equal to the stock thickness. This is a generalization that doesn't always lead to best results. For example if you are making a shallow box or drawer using ¾" stock, you can provide more glue area and thus more strength by reducing the cut width to about 50 percent of the stock thickness. I feel, and you might, that on such jobs narrower fingers are more attractive.

If you wish to be more creative by being a little more flexible, consider these thoughts:

A ⅜" finger looks pretty good on stock that ranges from ⅜" to ¾" thick. A ¼" finger is effective on stock that ranges from ¼" to ½" thick. If you ever work on material that is less than ¼", make the fingers the thickness of the material or just a bit less.

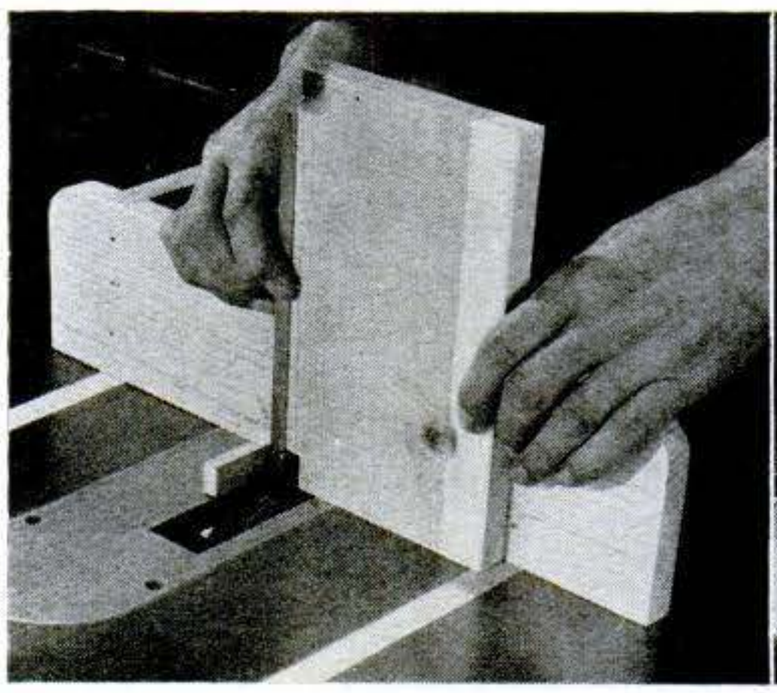
Unless you have a special reason, the fingers should not exceed ¾". This is for the sake of appearance and because the maximum cut for dadoes is about ¾". If you must make repeat passes to get the width you want on each finger, you are defeating the purpose of the idea.

The jigs. The independent one is a good idea because its double miter-gauge bars provide firm support on both sides of the cutter. It might appeal to users of small table saws (and thus small miter gauges) especially, since it provides more back-up than you can get with the usual small miter gauge.

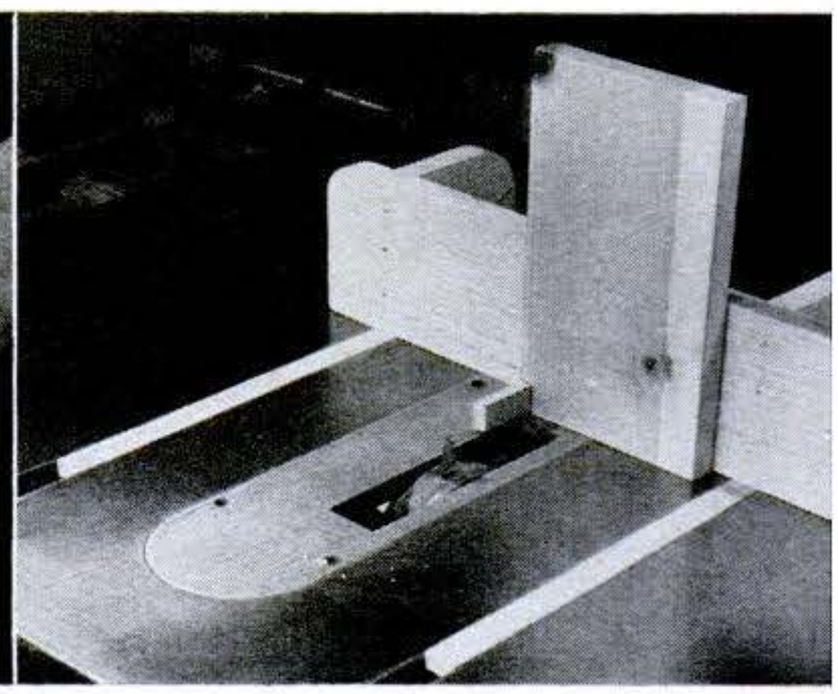
The others are just extensions, screw-attached firmly to the miter gauge. The adjustable one is designed primarily for those who anticipate frequent reliance on this type of joint and wish to be flexible in finger-size selection. The fixed one is so easily made that you can snap it out quickly when you need it.

The fourth version is not a fingerlap jig at all, but a variation that suggests the basic idea as a means of accomplishing other chores. Our example is used to production-cut half-

How to cut a fingerlap joint



1 Size spacer strip to match groove width, place between guide block and one of the parts. Hold firmly, make pass slowly.



2 Remove the spacer strip and place the first cut against the guide block as the second step in cutting the joint.

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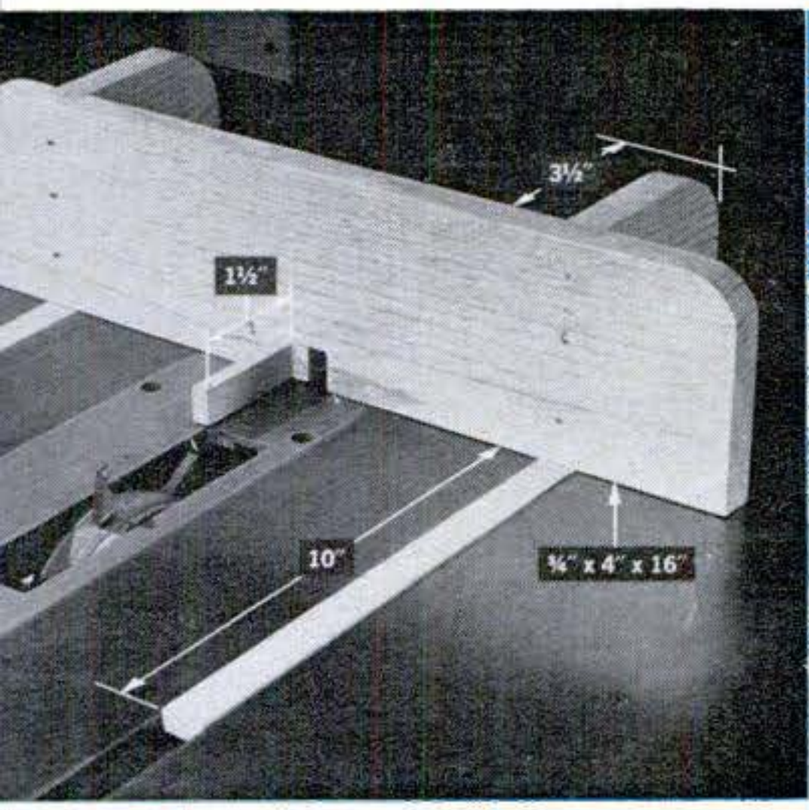
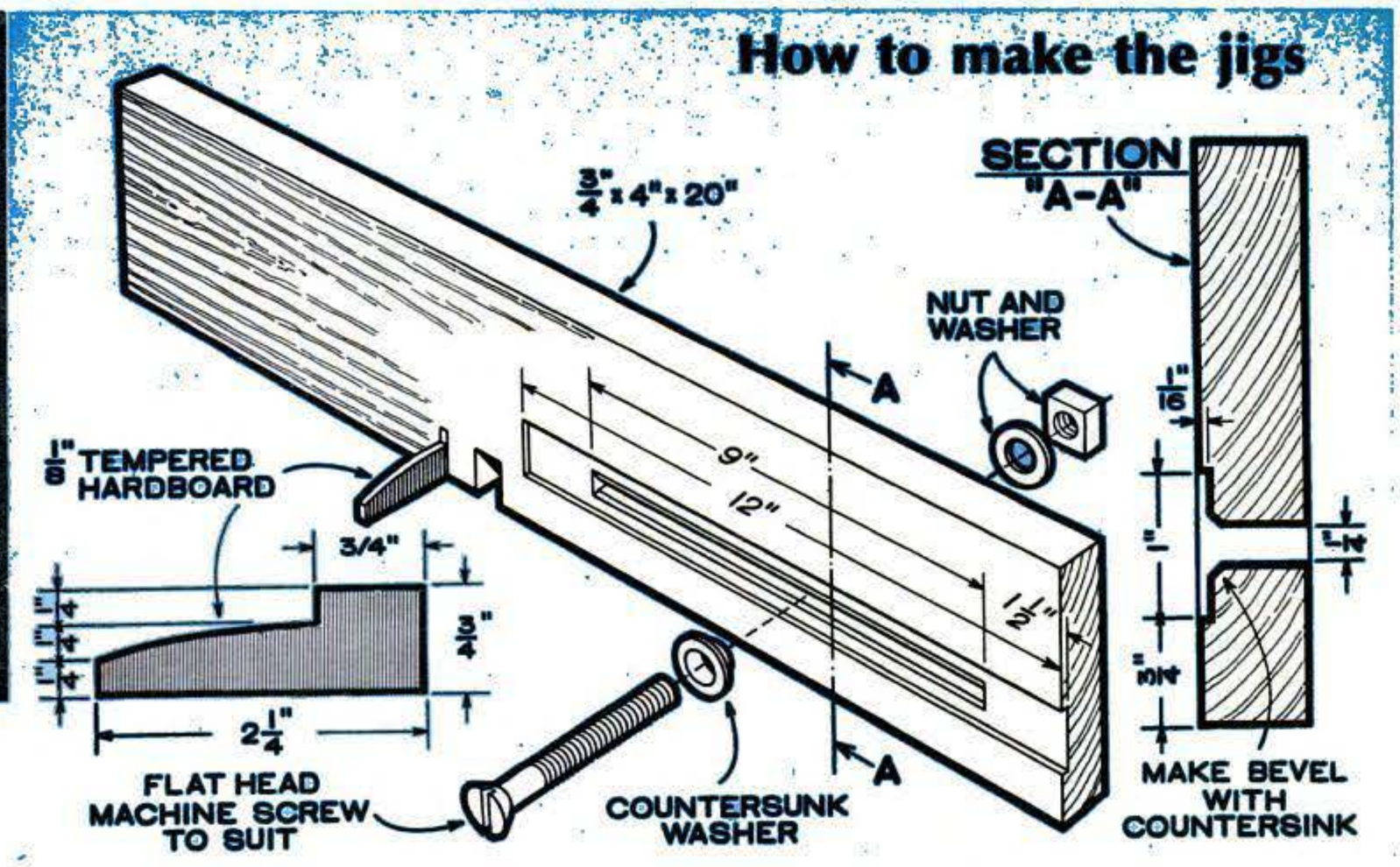
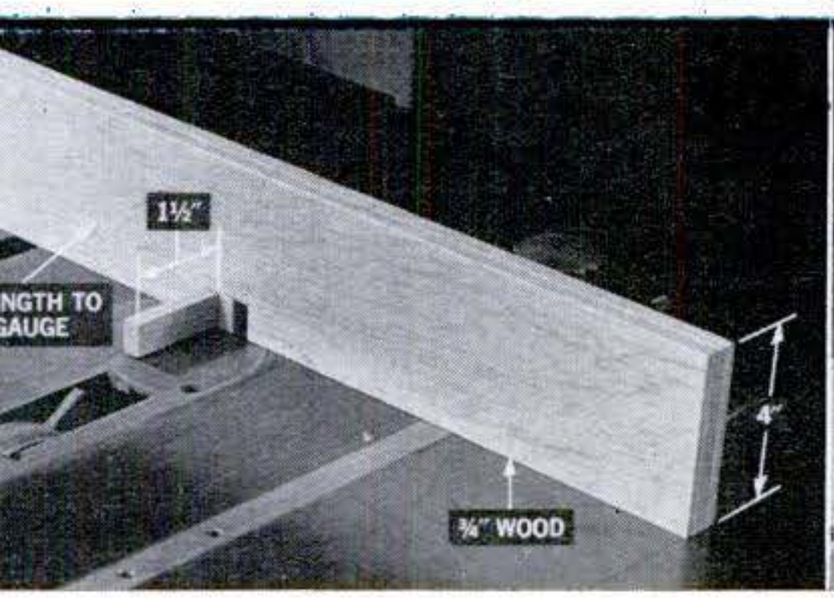
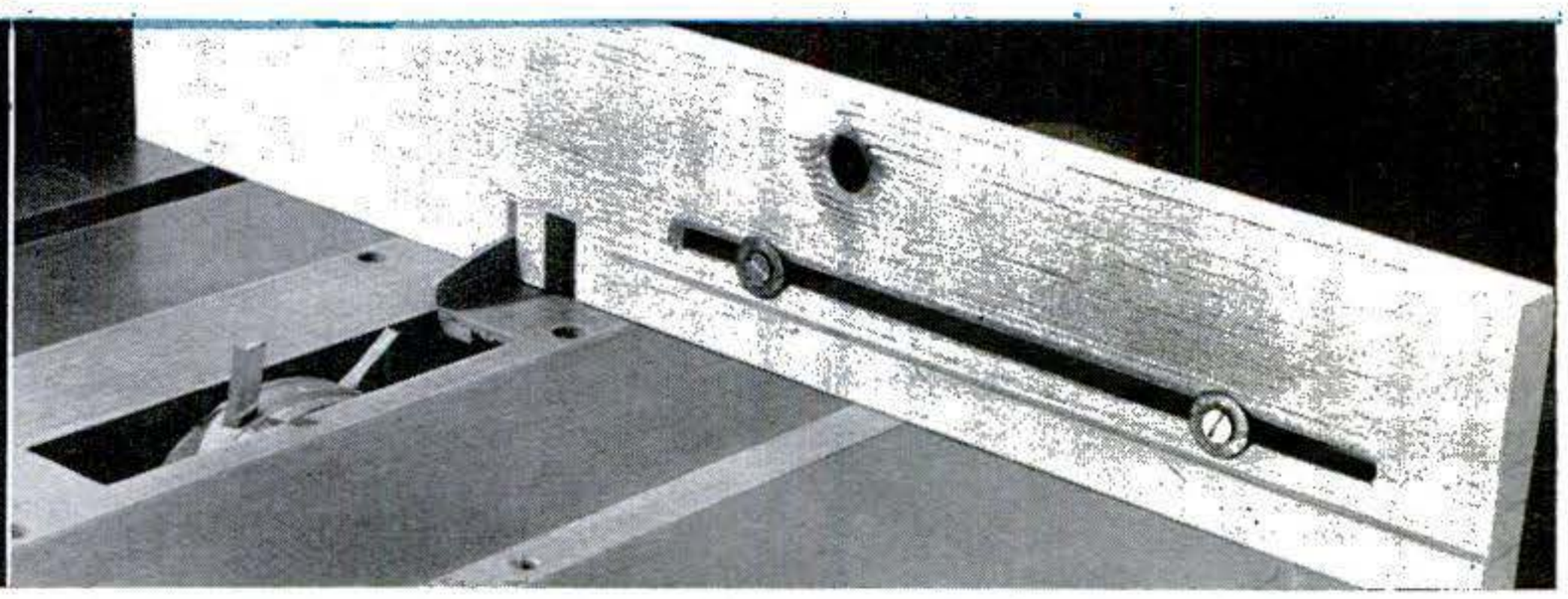
of the Expert Woodworker



Independent jig—so-called because you don't need a miter gauge—is one you probably will use most. A softwood like pine will serve well for making all the jigs.





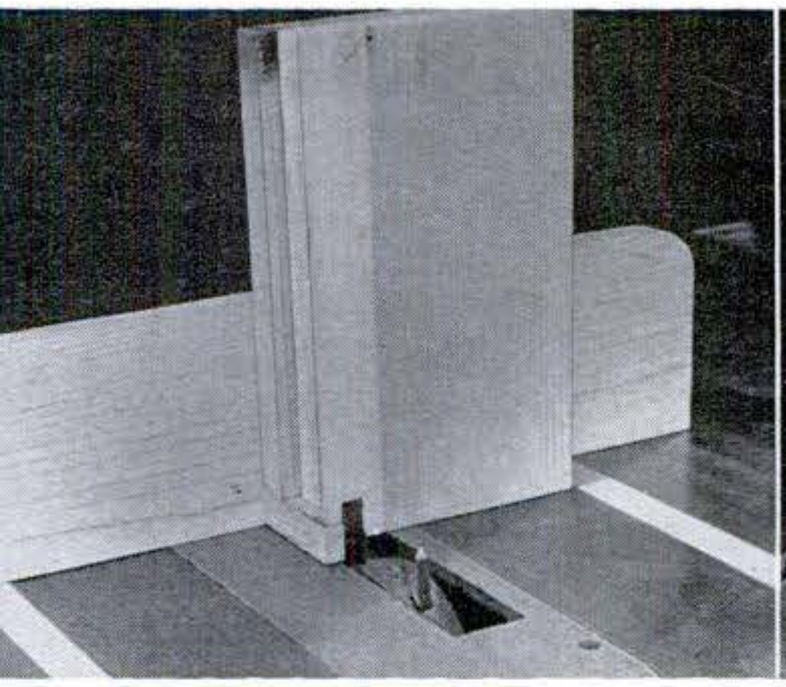


Fixed miter-gauge jig above works just like an independent jig. If you wish one groove size but want to work on different stock thicknesses, make several guide blocks to screw on rather than gluing on only one. Adjustable jig, at right in drawing and photo, provides various groove widths and permits fractional adjustments. Check dimensions against your equipment.

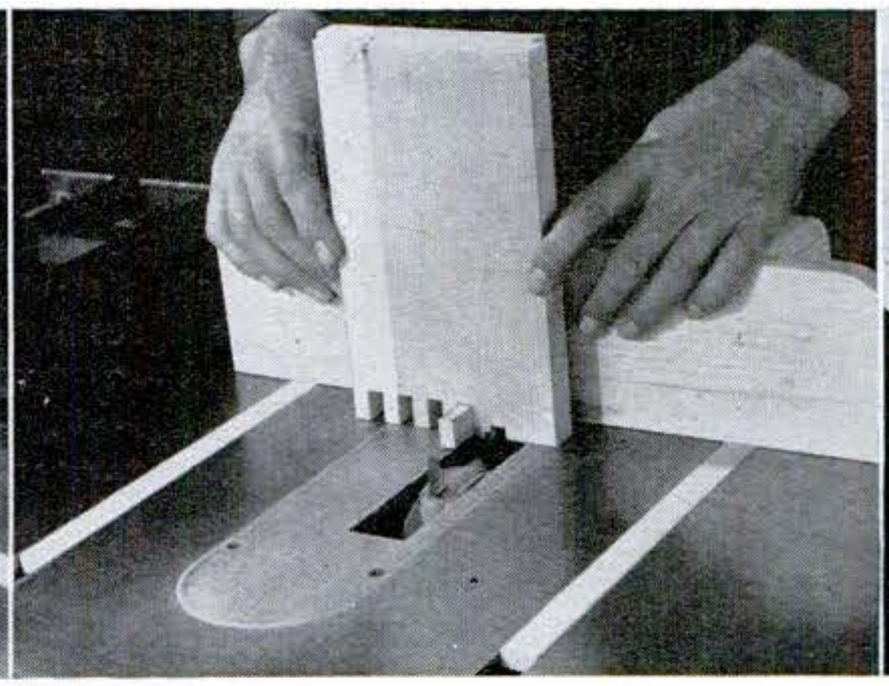
lap dividers for egg-crate partitions.

Making the independent jig. Saw the extension to size and then replace the saw blade with a dado. Set the dado tool for the thickness of cut you want and adjust its projection to equal the stock thickness. Screw-attach the extension to the miter gauge so you can make a pass close to the center of the extension.

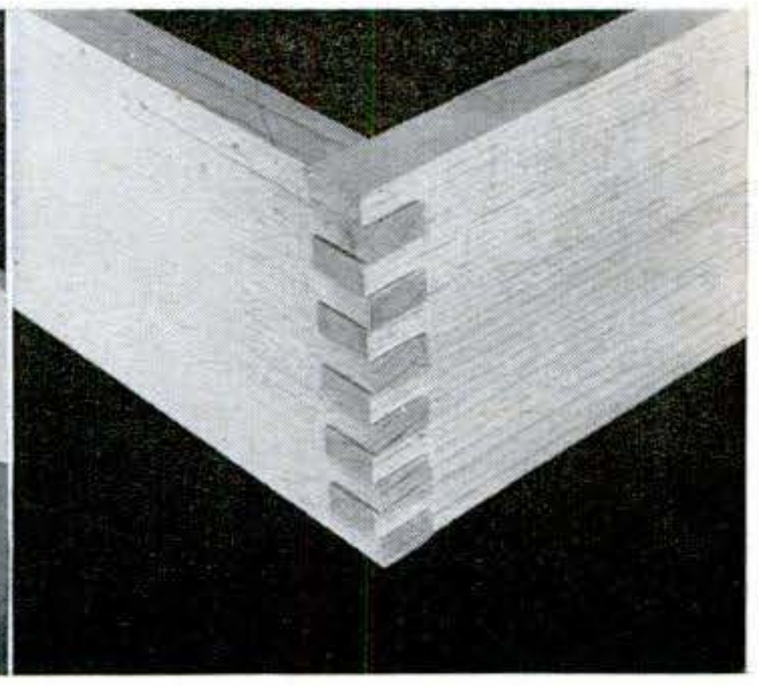
Make this cut and then remove the extension and make a second cut spaced a groove-width away from the first one. Make a guide block to fit the second cut and glue the block in place. A nail up through the bottom won't hurt. When you rescrew the extension to the miter gauge you are



3 Place the mating part against the guide block and make a pass to form groove in both pieces of wood simultaneously.



4 Seat grooves over guide block to position work for remaining cuts. You can handle any width work with any of the jigs.



5 For a perfect fit, make the fingers just a fraction longer than is necessary. Sand them flush after assembly.

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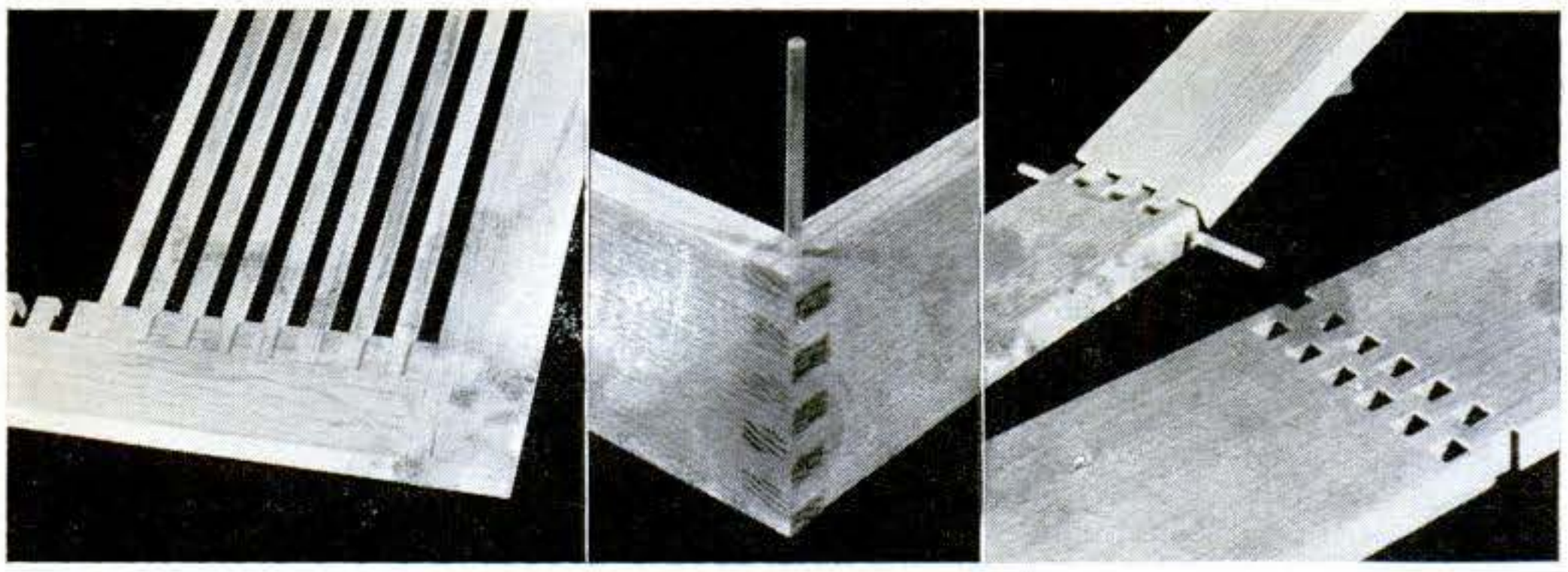
Variations on the fingerlap joint



The basic cuts can be used for making grille-type doors or similar projects as above left. The parts of a fingerlap do not lock together as do those of a dovetail, but you can accomplish such locking with a dowel. Fingerlap design makes an excellent end-to-end joint when you wish to stretch a board. You can also make a swivel joint by shortening the fingers after drilling a pivot hole through the assembled parts.

set for the fast production of fingerlap joints.

The groove in the adjustable extension can be formed by working with a router bit on the drill press, or you can form a slot by lowering the wood over a turning saw blade. The recess for the countersunk washer flange is simply a very shallow groove. In this case, attach the extension to the miter gauge by using two machine screws and nuts.

Precision is fine but don't work toward making the finger and groove so snug that you must mate them with a mallet. A slip fit is a better goal to aim for, since you then have some space between the parts for glue.

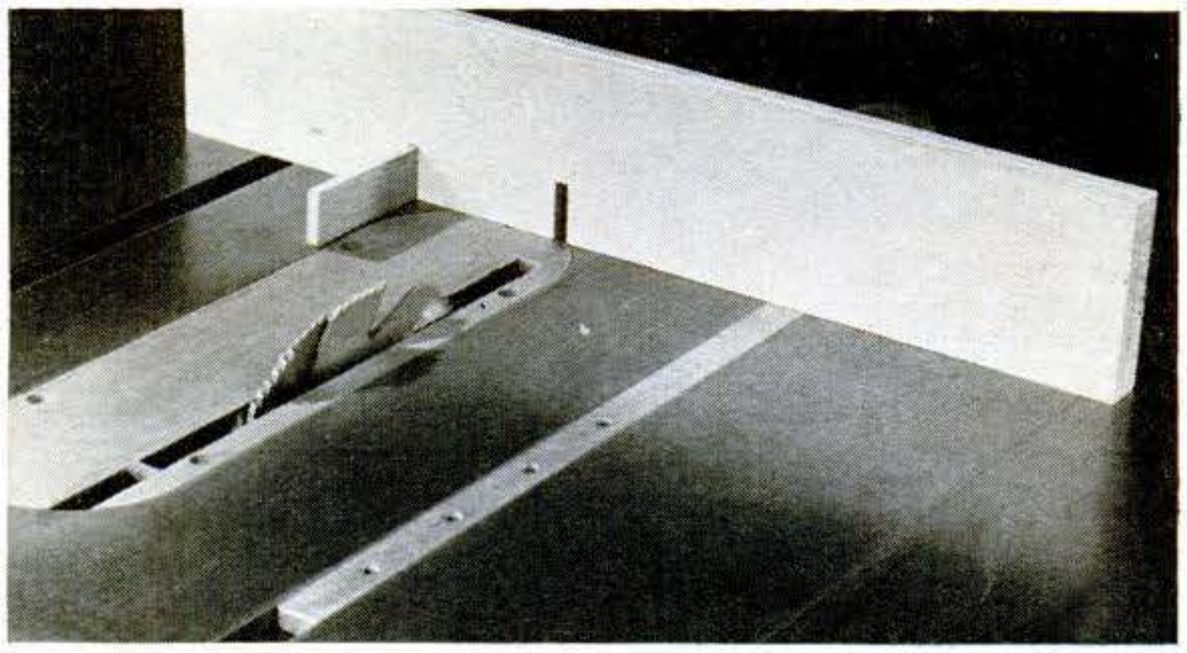
Using the jig. There are two ways to do this. The simplest provides for a full-size groove at one edge of the assembly. Do this by making the first cut in one piece, spacing it from the guide block with a strip of wood sized to match the groove width. Remove the strip of wood and butt the first piece against the guide block. Put the second piece in place, also butting it against the guide block. Then proceed with the cutting, placing each formed groove over the guide block to position the work for the next pass.

The second method provides for equalizing partial cuts at each edge of the assembly. Make a vertical line midway between facing edges of guide block and groove. Make a second vertical line on the centerline of the groove.

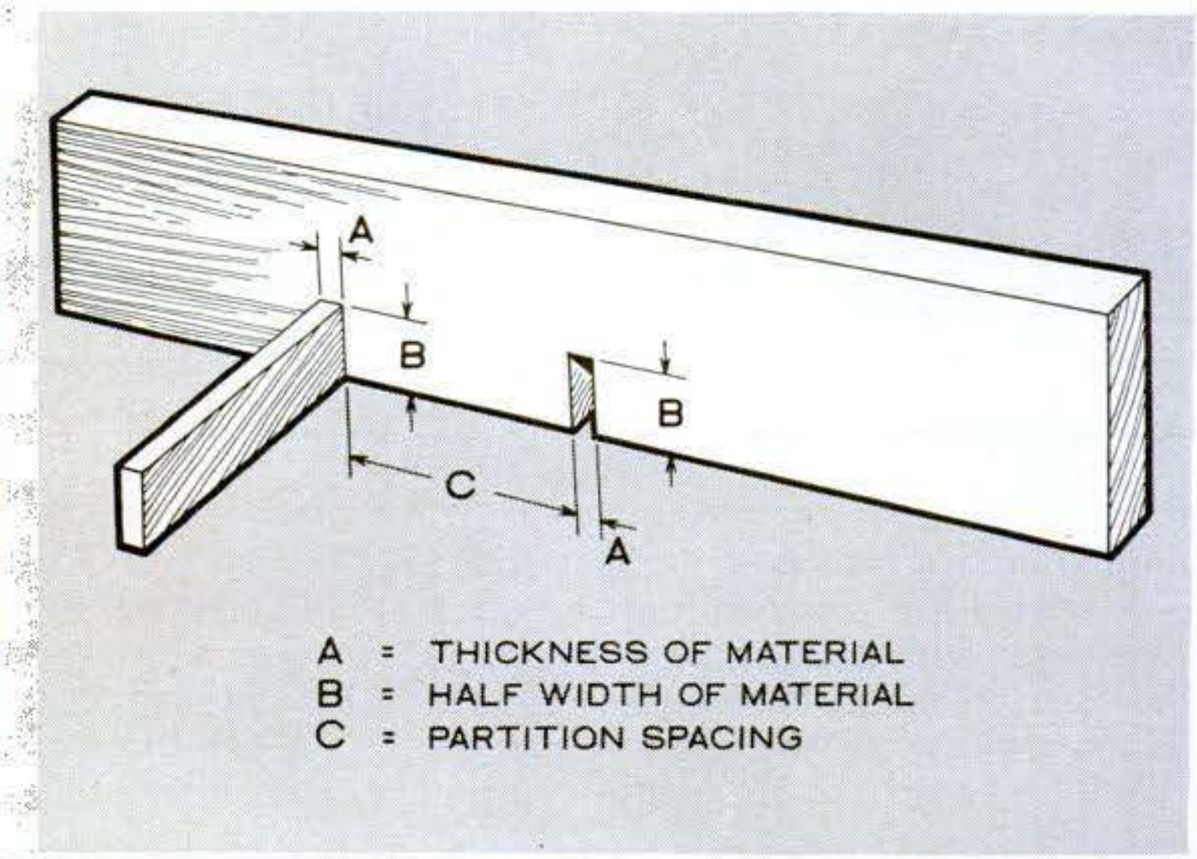
Now to start the work: Place one part in line with the first mark, the mating part in line with the second mark. Cut both pieces simultaneously and then butt the pieces against the guide block for the following cut. The first piece will hide the second guide line. So if you wish to be super careful, it might be a good idea to transfer this line to the work.

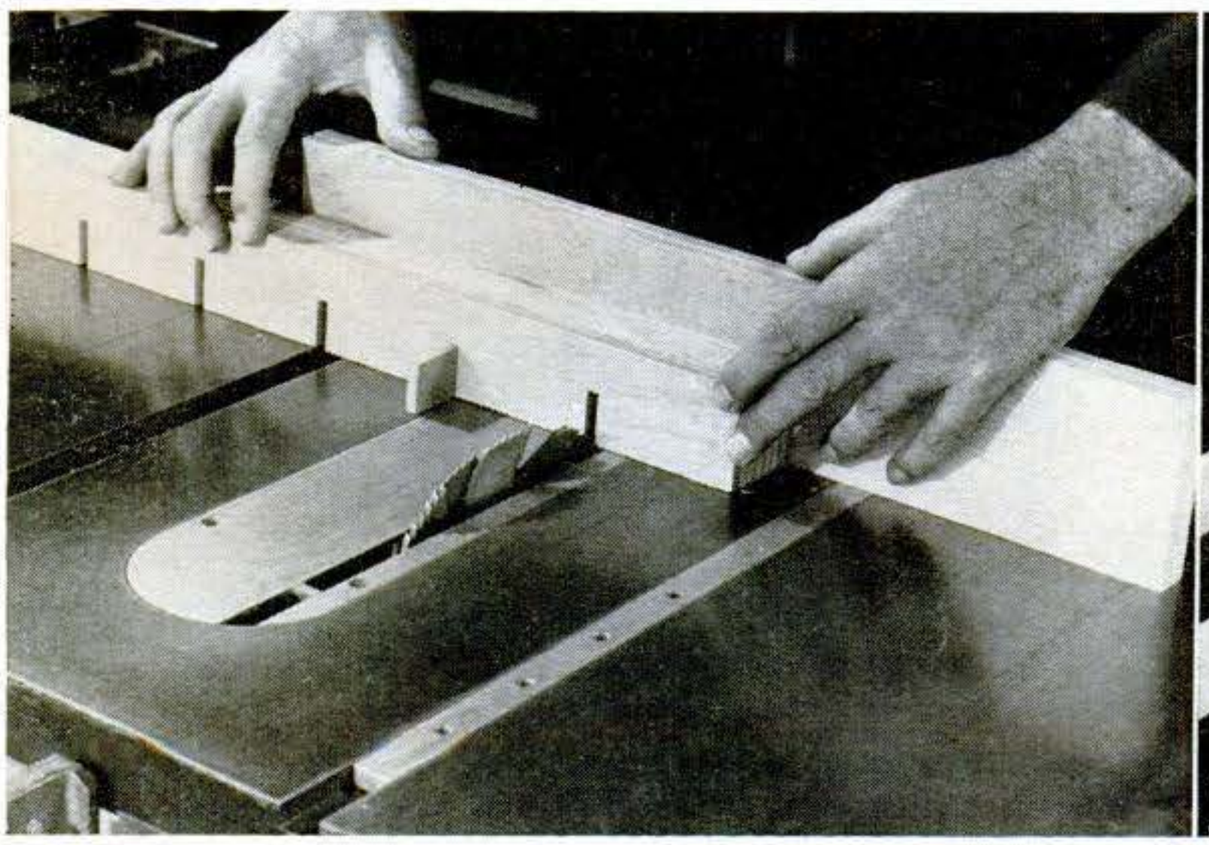
It's important, no matter what jig you work with, to keep the workpieces firmly together as you do the cutting. If you want more guarantee than hand-holding might provide, tack-nail the parts together for the cutting operation. Or perhaps you might hold them with clamps. Make cuts slowly and be sure the dado you use forms a flat-bottom groove. PS

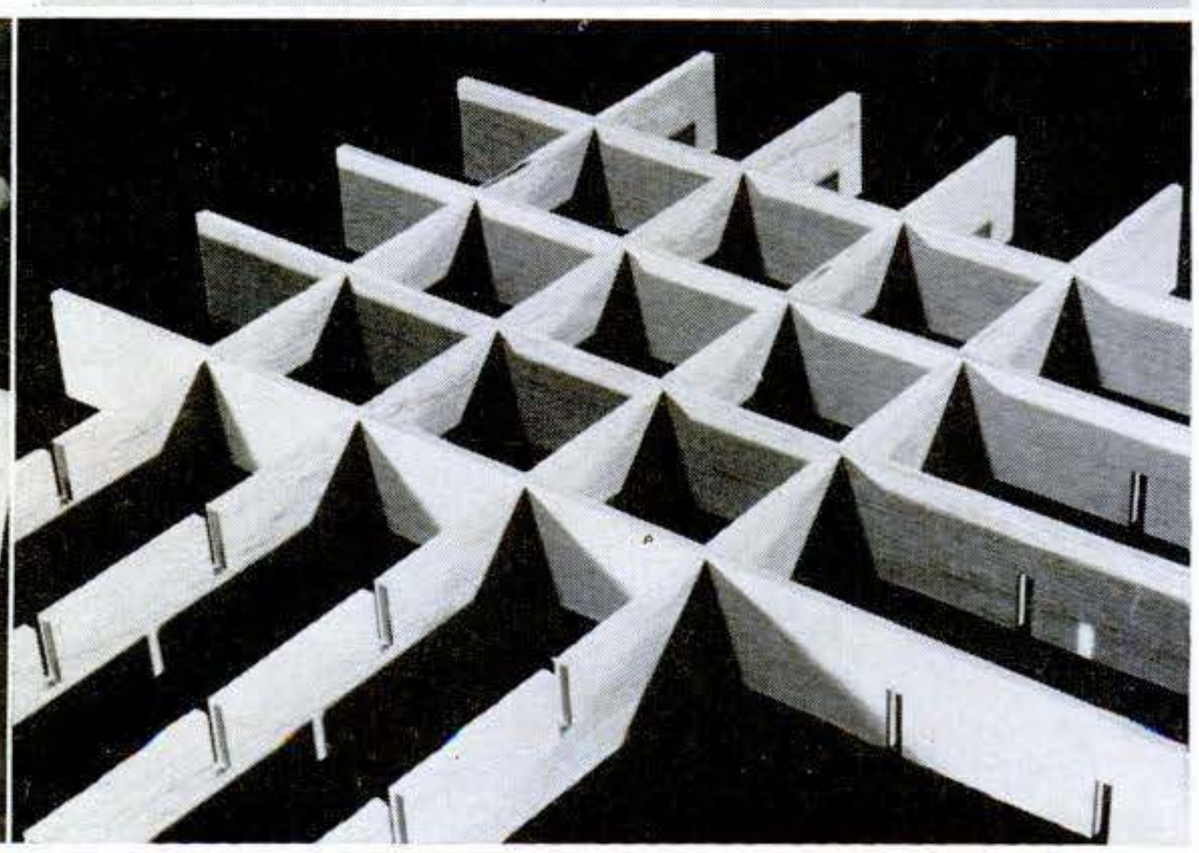
Jig for cutting egg-crate partition



Groove height is half the stock width. Groove width equals the stock thickness. These dimensions apply also to guide strip.







Hold the partition pieces firmly together as you seat the cut grooves over the guide strip for each pass. Finished half-lap dividers for egg-crate partitions are simple to form when you work with jig shown. It functions exactly like one for a fingerlap joint.

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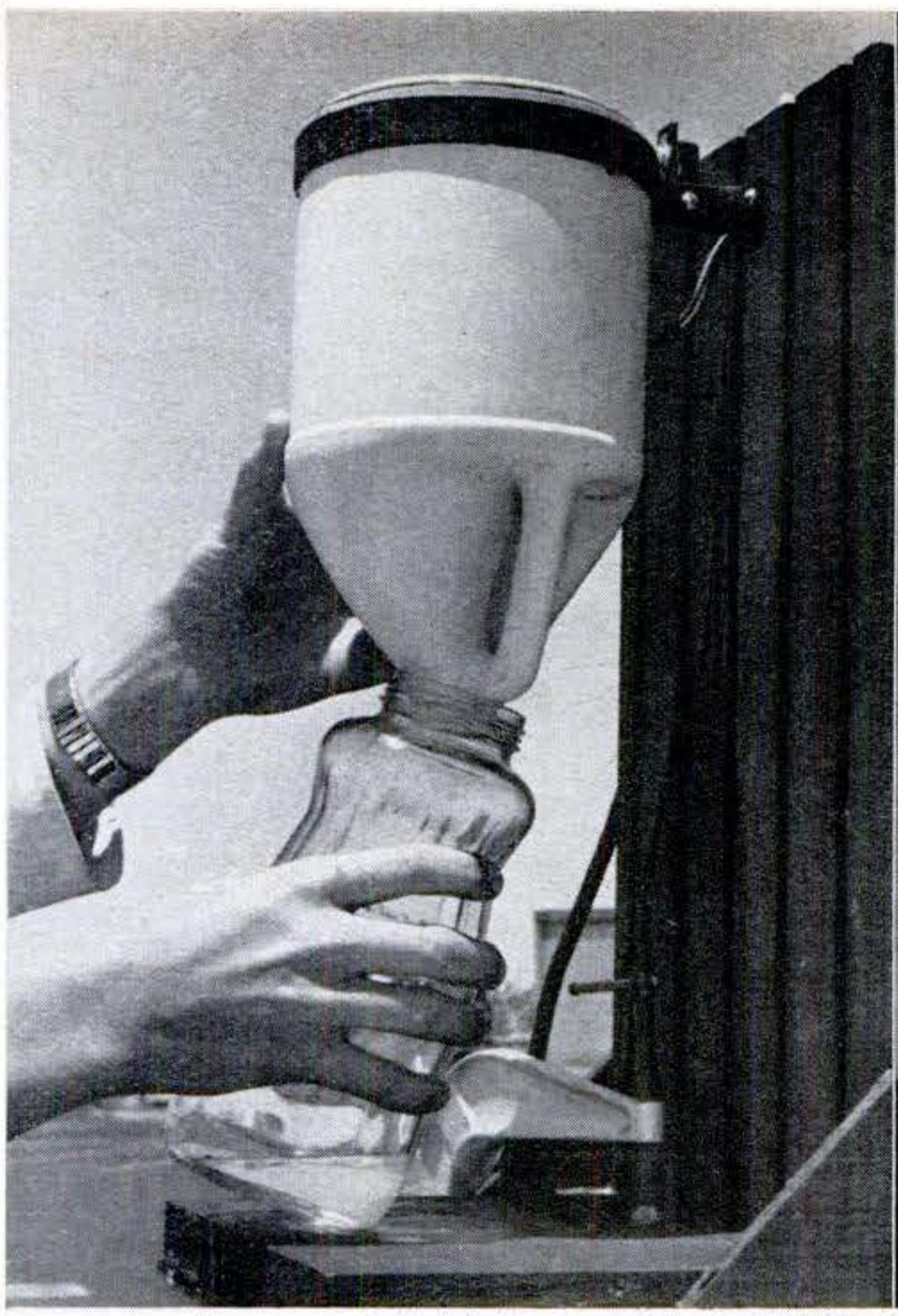

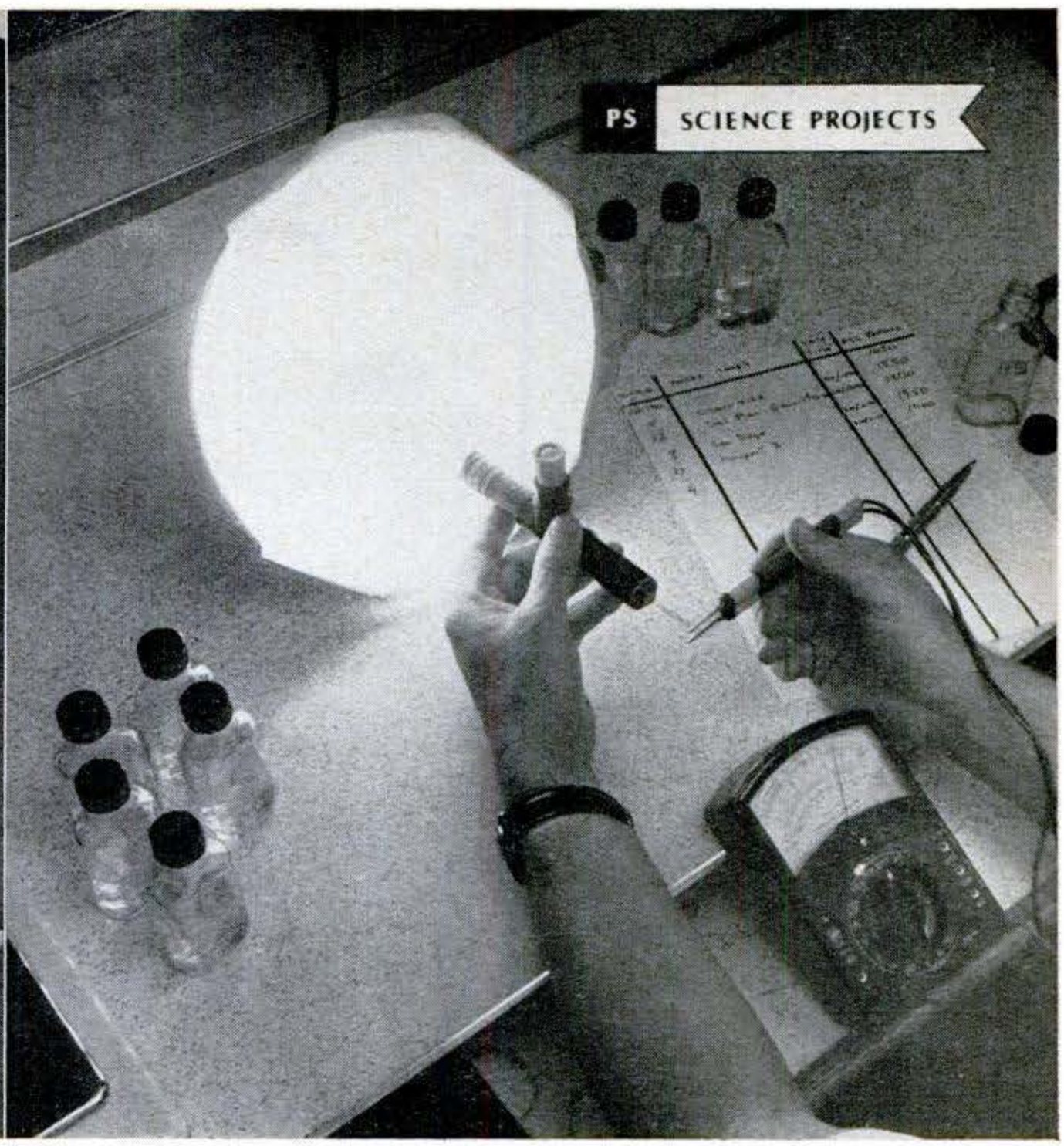

There are two parts to the tester. The impinger (above, at left) is used to collect samples of air you suspect is polluted. The hydrocarbon and other pollutant particles in it are suspended in an alcohol-water mixture. Then later, the optical density tester (above, right) is used to measure the level of actual particle pollution for each of the air samples that you've collected.

Build Your Own AIR-POLLUTION TESTER

With this device, you can measure hydrocarbon and other pollutants in the air

By RICHARD DAY and JON ORTMANN

How bad is air pollution in your community? In what parts of town is it worst? What days, and times of day, is pollution most prevalent? You can find answers to these and other local air-pollution questions with an inexpensive, simple-to-make setup for testing particle pollution.

Our system, called *wet impingement*, is based on a sophisticated procedure used by the National Air Sampling Network. Air is sucked into an impinger by a motor-blower unit, and forced over an alcohol-water mixture in a collection bottle. There it is swirled around, and the pollution particles are caught in the liquid for later analysis with an optical density tester.

Making your tester. Borrow a workable vacuum cleaner motor-blower unit from a tank-type or shop-vac machine. We used one from a five-gallon-size Black and Decker shop vacuum. Disassemble and *thoroughly* clean the motor and blower with soapy water to forestall pollution transfer from impinger to samples.

A round gallon-size plastic bottle makes a housing for the blower.

If the cut-open end of the plastic bottle is too big for your blower, you may need to fill the gap with a gasket. We used $^{3}/_{16}$"-thick sponge-rubber weather strip for this. Seal any gaps between the blower and bottle with silicone-rubber compound. Adding a switch, too, makes your impinger easier to use. A clean glass jar collects samples.

Now put together the plastic pipe tee for the optical density tester (see photo, following). You'll want a steady light source, one not too bright. A photocell reads well at low illumination, and a sheet of white paper lighted from behind by a 100-watt bulb does the job, as seen above. You'll need an ohmmeter, and though ours cost $19.95, you can get one for about $10.

Setting up for tests. Get a dozen 60cc (2-oz.) clear-glass bottles from your druggist and number them for identification. Pour 25cc of distilled water into each one. (Most such bottles are graduated to allow measurements.) Next, add 25cc of isopropyl alcohol to each. The 91-percent type is good enough. Don't use drinking or rubbing alky. The alcohol is a dispersion agent used to help keep pollution particles from settling out too quickly.

Pour both liquids directly from their containers to minimize the possibility of getting foreign matter in your samples.

To take a pollution sample, pour the contents of one sample bottle into

Continued

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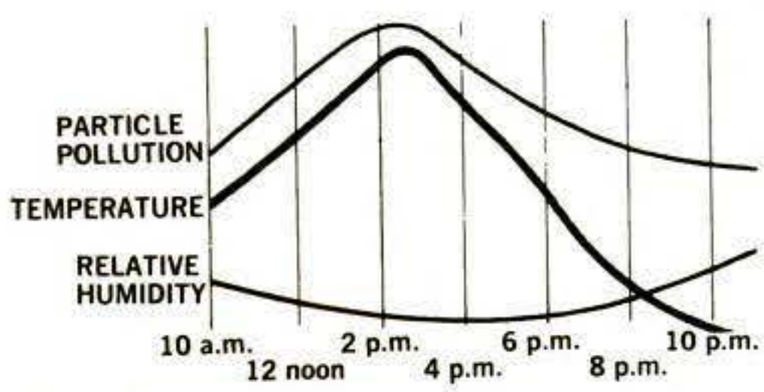
On a California pollution safari, the authors found polluted air more than a mile above sea level, near the 200-inch Hale telescope on Mt. Palomar (below), and near Los Angeles City Hall (at right). Pollution in the city proved unusually light because an offshore breeze that day had blown the smog inland.

the cleaned collection jar and spot the jar on the impinger. Turn on the impinger and run it for 15 minutes. Then, switch it off and pour the liquid back into its numbered bottle. Let it settle a minute. Then pour the clear top liquid back into the jar. Swish it around to scavenge any remaining particles.

A look at the liquid will tell you immediately whether the impinger picked up any particle pollution. Hold the bottle against the sky to see the larger particles. The smaller ones are indistinguishable, but they produce a noticeable overall cloudiness in the liquid.

Hydrocarbon particle only ¼ mm wide looms large in microphotograph. It was found in filtered and dried liquid sample.



Air pollution varies during the day, as graph above shows. In San Diego, pollution was low in the morning, but built rapidly after 10 a.m., and fell off in the afternoon as quickly as it had built up.

Note when and where the sample was collected. You may also want to record temperature, barometric pressure, humidity, wind, and appearance of the atmosphere.

Testing with the optical density tester is easy. Shake up an impinged-particulates sample to get all the particles in suspension, then pour it in the tee. To fill, you may have to top off the sample with alcohol because of evaporation during the collection. Be sure no air pockets are left inside the tee's run to affect the light reading. Cork the tee and shake it to suspend the pollution particles again.

Taking a reading. Aim the tee at the lighted paper so light shines through the tee's run to the photocell. Touch the ohmmeter prods across the photocell leads and take a reading. You may have to switch meter scales to find the right one.

Taking readings is faster if you tape the ohmmeter prods with their tips about ½" apart. Bend the photocell's two leads to angle away from each other. This lets you slip the prods over the leads where they are closely spaced and move them away from the photocell until contact is made. Before you record the reading, be sure to allow three seconds after shaking a sample for bubbles to dissipate.

It is usually several seconds before the needle comes to rest on a reading anyway, but don't delay readings for more than about 10 seconds after shakeup, or particles will settle out and give you a sub-accurate reading.

With every series of sample readings, you should include a control reading taken on an unpolluted water-alcohol mixture. Make control readings the same as you do on impinged-particulates samples. For utmost accuracy, make three separate shakings and readings of each sample and each control, then average them.

Reduce the raw readings to a form that lets you compare one against another. To get a particle-pollution percentage, subtract control reading from sample reading, divide by control reading, and multiply by 100.

$$\frac{\text{sample} - \text{control}}{\text{control}} \times 100 = \%$$

For instance: If a sample scales 1,650 ohms and its control scales 1,050 ohms, the pollution percentage is 57. With percentages you can stack your readings against ours or those of friends who build the test setup. As percentages, the readings can be graphed, the zero line representing an unpolluted sample.

Looking at particles. Further tests call for the use of a microscope to identify particles. The dark ones that quickly settle to the bottom of a sample are the larger of the hydrocarbons spewed out of an auto exhaust or a smokestack.

You can isolate these for microscopic study by running the sample liquid through a filter paper, drying it, and putting the particles on a glass slide. Examined under a microscope of even moderate power, hydrocarbon particles look like black flakes with fairly smooth-textured bumps on the

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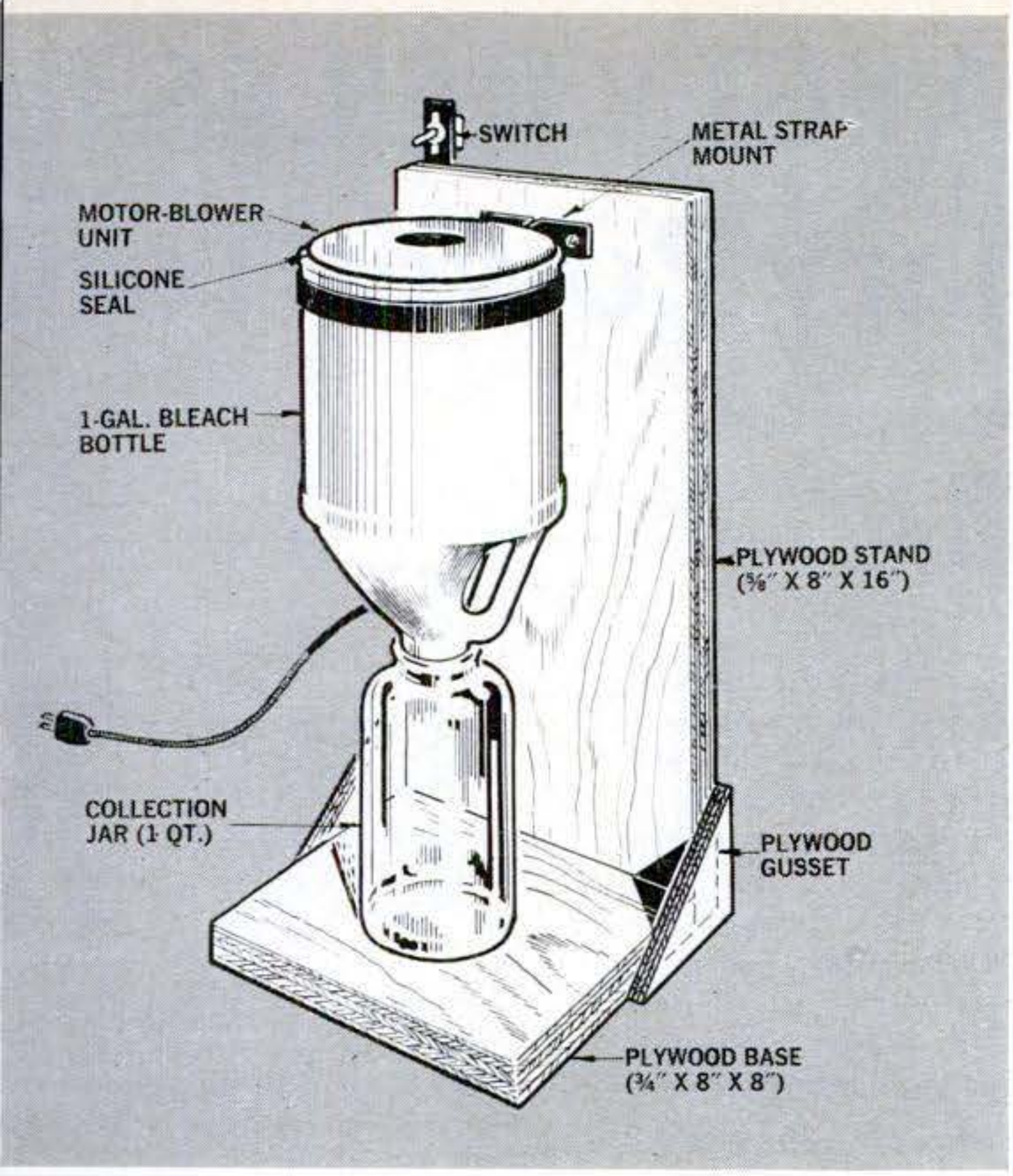

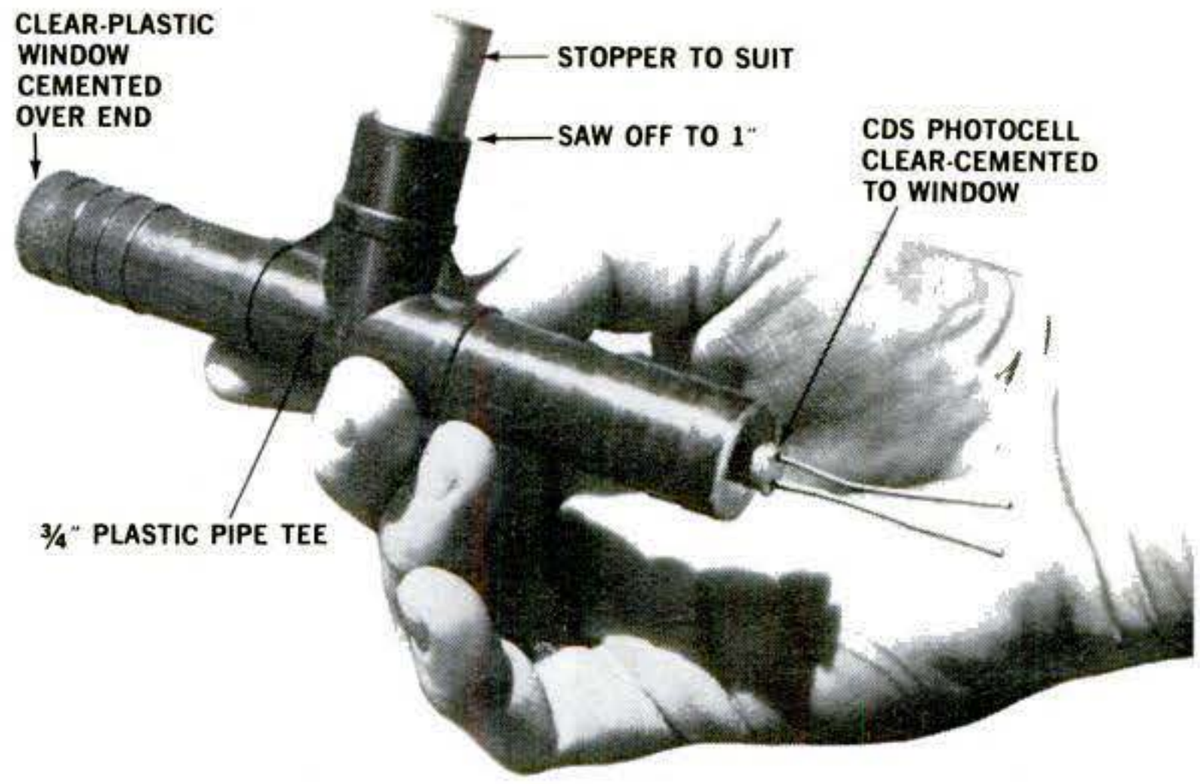

Make the impinger, at left, from a gallon plastic bleach bottle with the bottom cut out. Slip it tightly around the motor-blower unit from a tank-type vacuum cleaner so air will blow out of the bottle's mouth. Carefully seal the end of the bottle to the unit to prevent leaks. Bring the motor leads out through a small hole drilled in the side of the bottle, and attach them to the switch on the back of the stand. Mount the bottle and unit on the stand with a metal strap. To adapt the plastic pipe tee for the density tester (above), cement two clear-plastic disks to cover and seal off "run" openings. Saw off the tee branch and cork it. Then, cement the CdS photocell into one of the clear windows so it looks through into the tee.

sides. They have a crystalline appearance.

You can make a positive hydrocarbon identification by microscopically comparing air-collected particles with ones picked up on a wet drinking glass held in the exhaust of an idling engine. Our air collections around Southern Cal snared hydrocarbon bits ranging in size from 1/40 to 3/40 of a square millimeter.

If you have access to a delicate chemist's balance scale and weights, you can weigh collected particles. First, weigh a piece of filter paper. Filter the sample through it, dry the paper, then weigh it again. The difference represents pollution particles. Some of our most polluted samples contained two grains of particle pollution. We found excellent correlation between particle weight and optical-density-tester readings.

Besides hydrocarbon particles, you will probably pick up traces of lint, dust, and hair. We even found what looked like plant matter.

Testing on the go. To get a cross-country pollution profile, we took our impinger on the road from Los Angeles to San Diego. You can make a smog safari of your own if you can lay hands on a portable electric plant to power the impinger. We used a 120-volt Pincor unit pirated from a friend's vacation house. We mounted the test rig on the roof of a pickup, the generator in the bed. One of us rode in the bed to operate the impinger. All tests were made on the move so that our own auto pollutants were left behind.

Showing that pollution can be found anywhere, the particle sampling taken near President Nixon's San Clemente retreat was worse than any taken at other small towns on our trip.

Interpreting your tests. Your homemade pollution-test setup is not intended to be scientifically accurate. For one thing, carbon particles from the motor's brushes could be picked up. The effect would be slight, but constant. Also, we theorize that some airborne particles lodge on parts of the motor and blower, never making it into the liquid.

What's more, the liquid is probably not more than about 20 percent efficient in trapping particles that enter the impinger. And the smaller the particles, the more likely they are to slip through.

Other inaccuracies could come from voltage variations, which would affect blower speed and resultant air volume. Uniform voltage is also needed to produce uniform optical-density-tester readings. And a bug ingested by the impinger could falsely increase the pollution reading.

For these reasons, treat your measurements as guides, not as absolutes. You can use them to develop a smog index of your own. Any pollution of more than 20 and up to 60 percent, we'd tend to call *light;* anything from 60 to 100 percent, *moderate;* and anything more than 100 percent, *severe.*

The terms need not correspond to the ones used by antipollution agencies. But with enough testing and comparison you probably could calibrate your tests to match those the pros make.

If your community has no local source of pollution reports, you might offer your data to the local newspaper or radio station. Everyone generally agrees that something must be done. Where is there a better place to start than at home?

Building and using a pollution tester is one way of getting involved. Taken out and about, it will draw concerned attention from all sides—like a wit we met in L.A. After hearing what we were doing with the impinger, said he: "Leave the durn thing on; maybe it'll collect all the smog."

It won't, but it will collect enough to let you see how bad off your town really is. PS

MATERIALS LIST

IMPINGER:
- Motor-blower from tank-type household or shop vacuum cleaner
- Plastic bleach bottle (1 gal., round)
- ⅝" plywood 8"x16" (backboard)
- ¾" plywood 8"x8" (base)
- Plywood scrap (gussets)
- Sponge-rubber weather strip or other suitable gasket material
- Metal strapping (about ½" wide)
- Silicone-rubber compound
- Toggle switch
- Cord and plug
- Collection jar (about 1 qt.)
- ⅛" bolts ¾" long (3)

OPTICAL DENSITY TESTER:
- ¾" plastic pipe tee
- Cadmium sulfide photocell (RCA No. SQ2544V1 9Z or any CdS cell for general application; order from Allied or Lafayette catalogs)
- Clear sheet-plastic scrap
- Rubber or cork stopper to suit
- Volt-ohm-milliammeter (Allied Radio No. 24C9594 illustrated)

MISCELLANEOUS
- 60cc (2 oz.) clear-glass bottles
- Isopropyl alcohol (91%)
- Distilled water

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New SAFETY RULES fo Stationary Power Tool

Follow them for best results and full benefit from shop machines

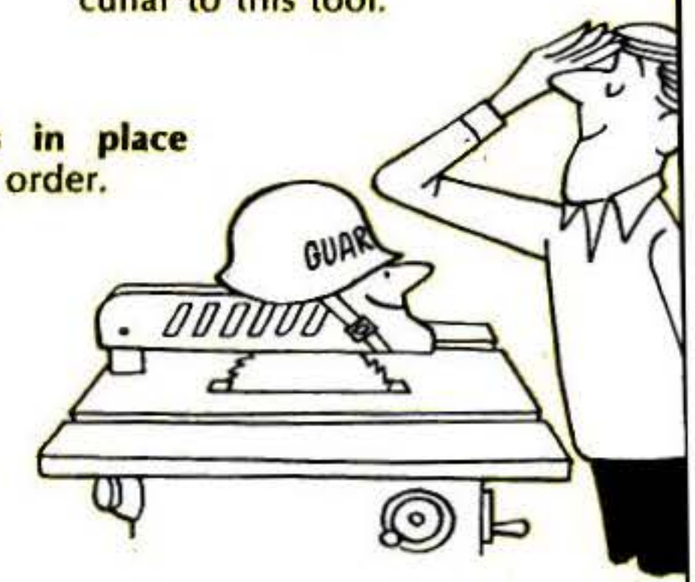
DRAWINGS BY ROY DOTY

Every good craftsman respects the tools with which he works. He knows they represent years of constantly improved design. He also knows that they are dangerous if misused.

This is the theme of a new safe-use program developed by the Power Tool Institute, Inc., for stationary power tools. The Institute has put together a list of safety rules, based on approved practices in industrial and home shops, to accompany a set of new standards for stationary power jobs that members of the Institute manufacture.

1 Know your power tool. Read owner's manual carefully. Learn applications and limitations, as w as the specific potential hazards p culiar to this tool.

2 Keep guards in place and in working order.



3 Ground all tools. If tool is equipped with three-prong plug, it should be plugged into a three-hole electrical receptacle. If an adapter is used to accommodate a two-prong receptacle, the adapter wire must be attached to a **known ground. Never** remove the third prong.

4 Remove adjusting keys and wrenches. Form habit of checking to see that keys and adjusting wrenches are removed before turning on tool.

5 Keep work area clean. Cluttered areas and benches invite accidents.

6 Avoid dangerous environment. Don't use power tools in damp or wet locations. Keep your work area well illuminated.

7 Keep children away. All visitors should be kept a safe distance from work area.

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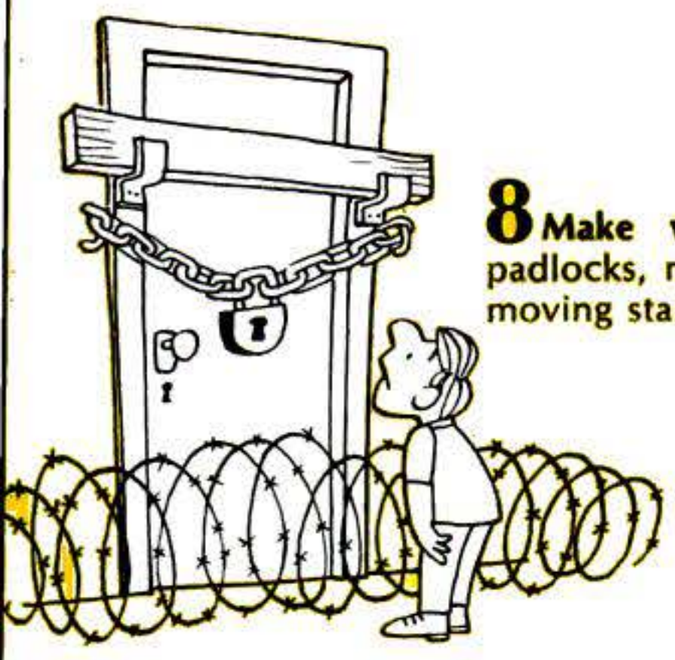
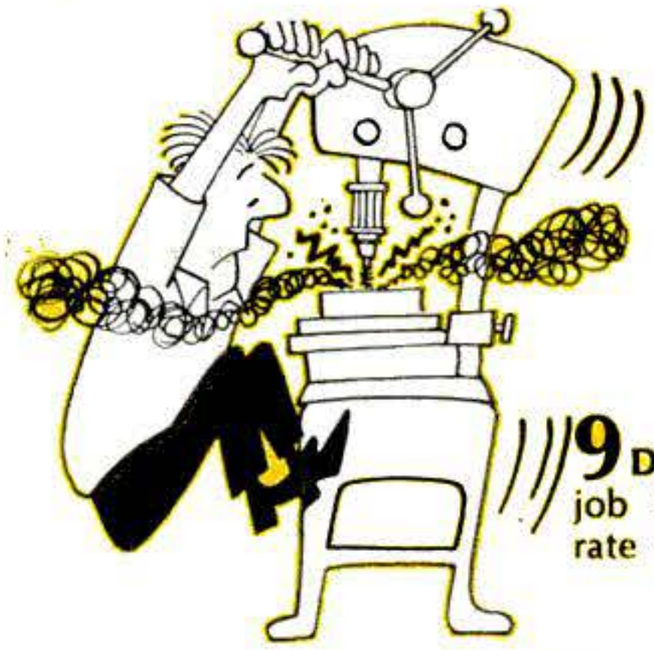
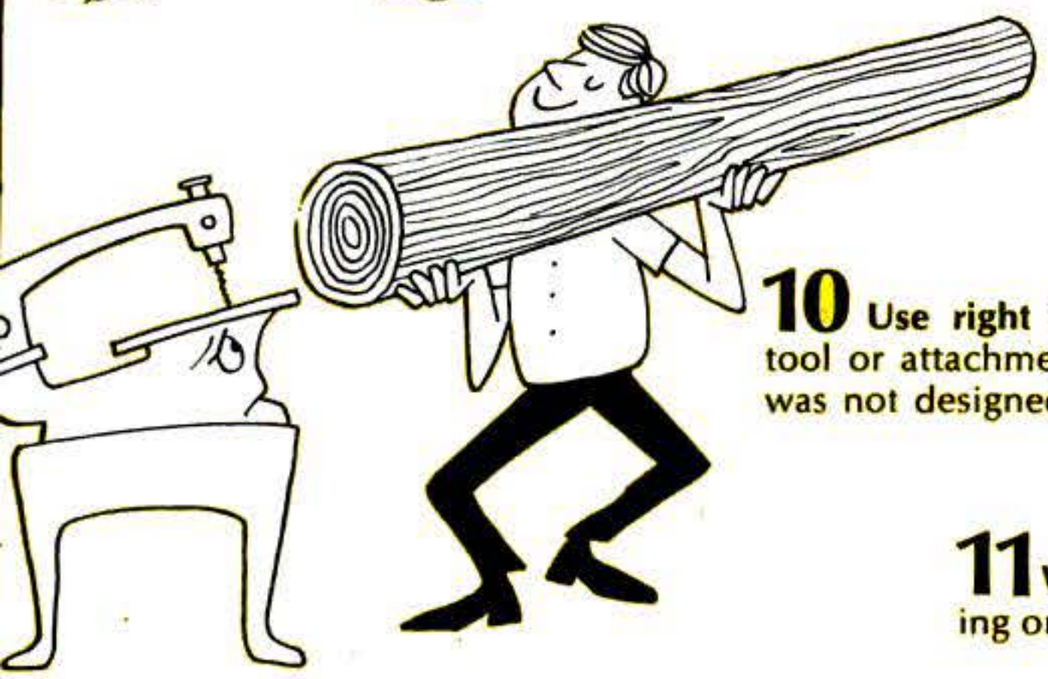


8 Make workshop kidproof—with padlocks, master switches, or by removing starter keys.



9 Don't force tool. It will do the job better and be safer at the rate for which it was designed.



10 Use right tool. Don't force tool or attachment to do a job it was not designed for.

11 Wear proper apparel. No loose clothing or jewelry to get caught in moving parts.

12 Use safety glasses. Also use face or dust mask if cutting operation is dusty.

13 Secure work. Use clamps or a vise to hold work, when practical. It's safer than using your hand, frees both hands to operate tool.

4 Don't overreach. Keep your proper ting and balance at all times.

15 Maintain tools in top condition. Keep tools sharp and clean for best and safest performance. Follow instructions for lubricating and changing accessories.

16 Disconnect tools before servicing and when changing accessories such as blades, bits, cutters.

17 Use recommended accessories. Consult owner's manual. Use of improper accessories may be hazardous.

18 Avoid accidental starting. Make sure switch is off before plugging in cord.

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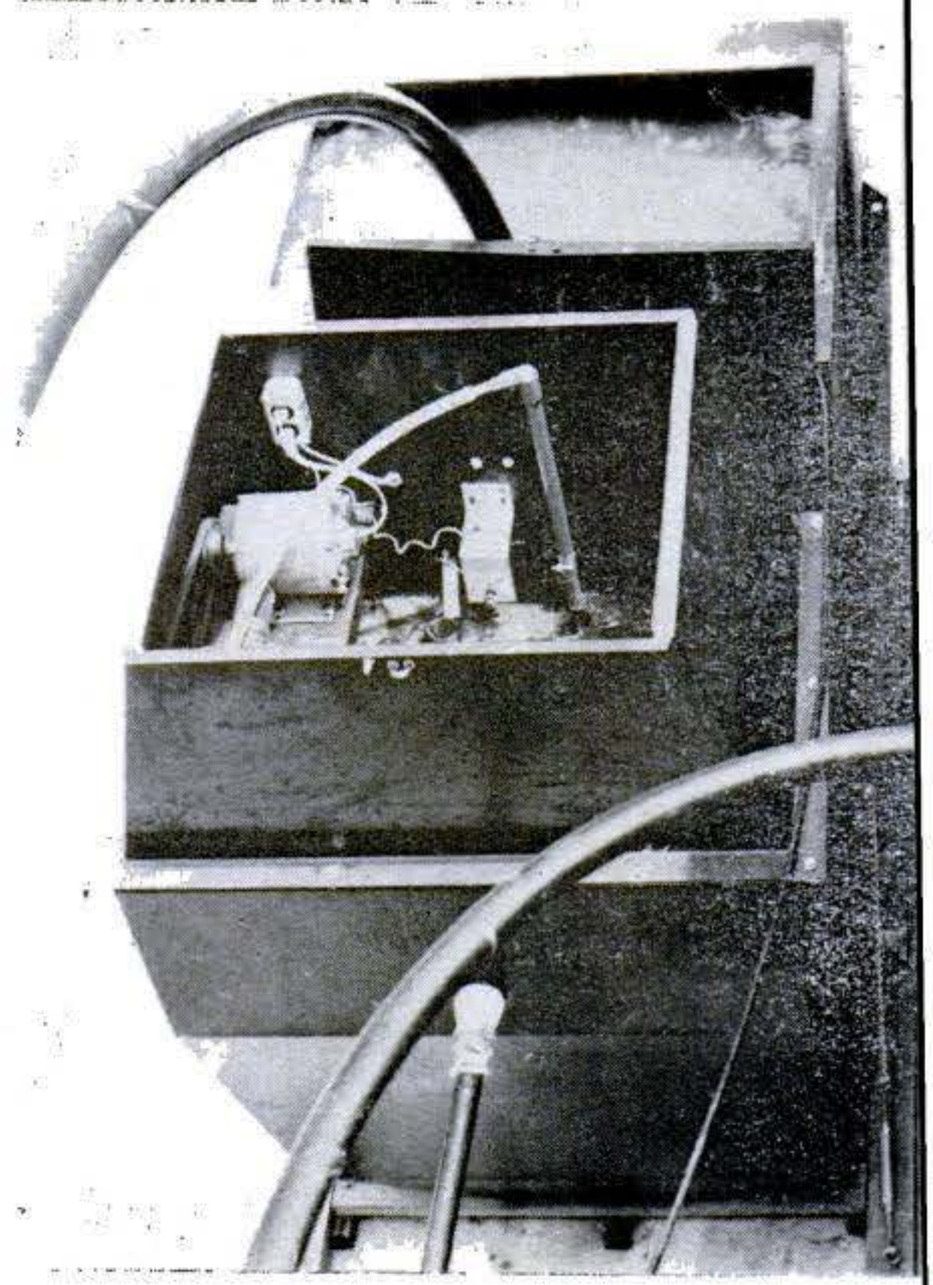
Lindsley found no odor from this aerobic system being tested at the National Sanitation Foundation—even in open operation. In use, unit would be buried.



AEROBICS— It Can Solve Your Sewage

No city-sewer hookup? A better solution than the septic tank is on the way

By E. F. LINDSLEY

Bacteria and bubbles may solve your waste-water disposal problems if you are among the 74 million persons in the country whose homes lack a connection to a municipal sewer. About 25 percent of the individual households in the United States depend upon septic-tank, soil-absorption systems for sanitation.

The septic tank, fine for the old-time farm house with a single kitchen pump, is often far from adequate for modern plumbing and appliances. Match this with a mass flight to suburban areas where the soil may be totally unsuited to absorption and you can count yourself among the lucky ones if the effluent from your home does not pollute the local lake or stream—or your neighbor's or your own well. Those with a septic disposal system functioning without trouble need read no further. It's a simple and inexpensive system.

But if you plan to build a summer cottage, or buy or build a new home away from city services, it may pay to consider something better. Today, some manufacturers are building miniature waste-water treatment plants for single-home or multi-home use. Not all such plants (called "package plants" because they are delivered as a manufactured unit) meet the rigorous standards necessary to protect your own and your neighbor's health. Nor will all community authorities permit their installation. But, intensive work is being done to establish performance standards and solve the problems. A package plant might well make it possible to build and live where sanitation would otherwise be in doubt.

How they work: Package units generally function on the aerobic principle, as opposed to the time-honored anaerobic—air-free—septic tank. The septic tank excludes air from the waste water and permits anaerobic putrefaction to break down the material to a smelly effluent suitable for underground disposal in a leach bed or dry well. The new aerobic units mix air and waste water to allow air-using bacteria to do the breaking down. Both systems are "time dependent" and require flow and loading rates matched to their capabilities.

Proponents of aerobic treatment claim the effluent is so clear and inoffensive it may be suitable for surface disposal as irrigation water or simply into a ditch or stream. Opponents, who include many public health officials, do not feel the effluent is always so clean. They say ultimate disposal is still a problem. More on this later.

Basically—to be practical—a package unit should. . .

- Produce a well-treated effluent.
- Have skilled local maintenance.
- Be noiseless.
- Consume minimum power.

The more sophisticated aerobic units consist essentially of two or three concrete or metal tanks divided by internal walls. Incoming sewage, or waste water, as the engineers prefer to call it, is brought either into a primary settling-tank section or into the aeration-tank section. In the aeration tank, various means of agitation and air bubbling are used to add oxygen and permit air-using bacteria to decompose nutrients in the influent. The agitators may be simple perforated pipes, or combined air pumps and propeller-like agitators immersed in the fluid. Timer switches control the action intermittently. The water passes at a managed rate to a settling chamber where bacterial matter and solids settle out. Clear effluent flows to the disposal area; a portion of the sludge returns to the aeration chamber to activate fur-

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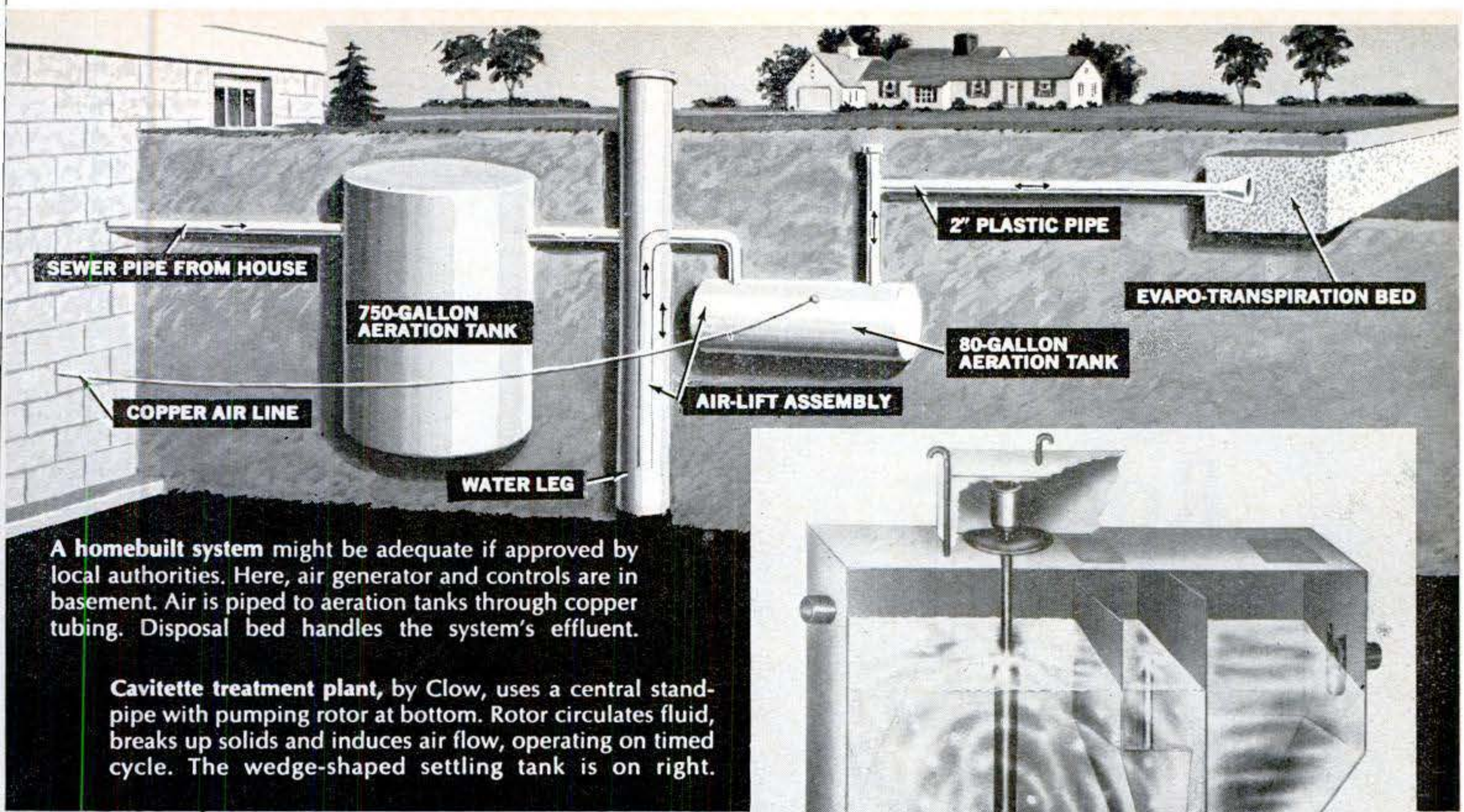
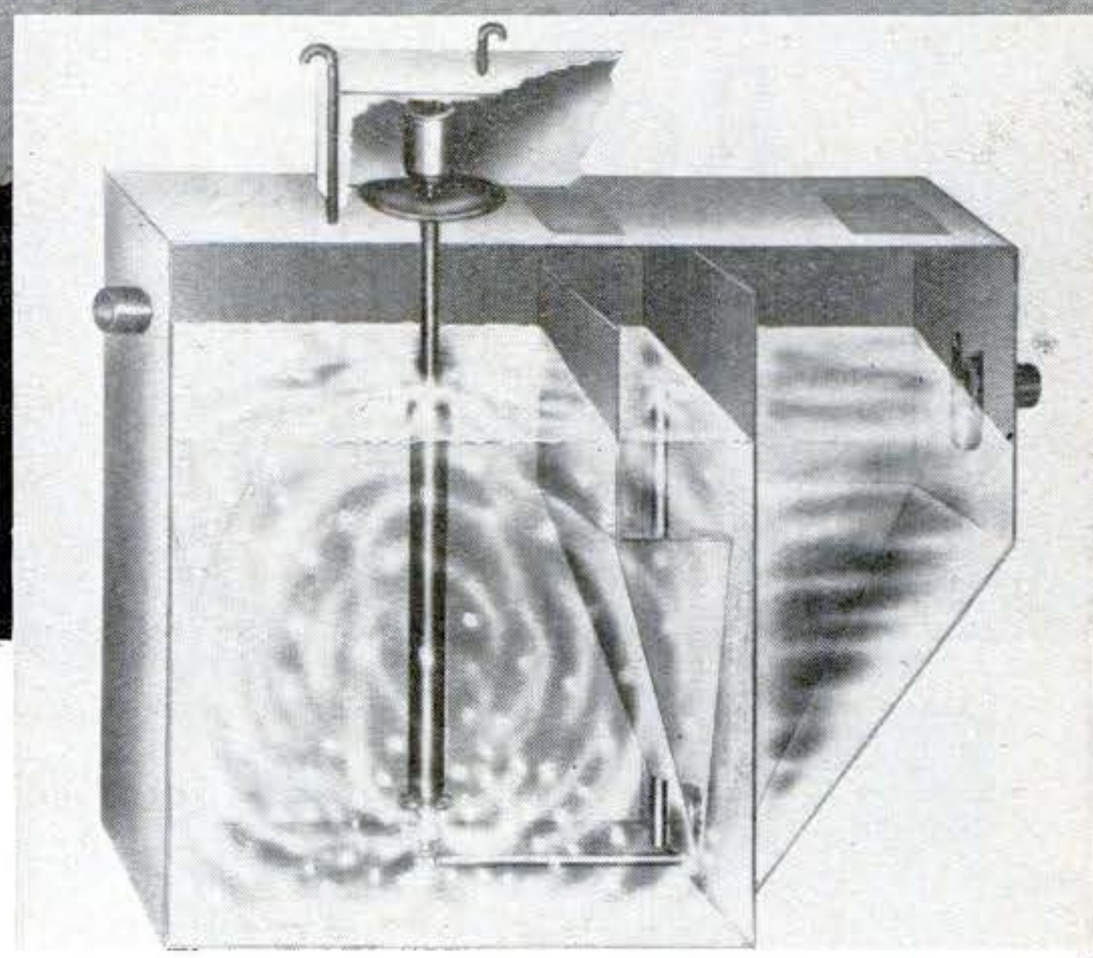


A homebuilt system might be adequate if approved by local authorities. Here, air generator and controls are in basement. Air is piped to aeration tanks through copper tubing. Disposal bed handles the system's effluent.



Cavitette treatment plant, by Clow, uses a central standpipe with pumping rotor at bottom. Rotor circulates fluid, breaks up solids and induces air flow, operating on timed cycle. The wedge-shaped settling tank is on right.

Problems, Too

ther treatment. At long-term intervals, inert sludge from inorganic material may require pumping out. The advantages claimed for aerobic treatment:

- Effluent generally cleaner than from anaerobic treatment; comparable to municipal secondary treatment.
- Less clogging in soil-absorption systems.

The reduced-clogging feature is the key to aerobic treatment's attraction. Now, a septic tank with good soil absorption is cheap and effective. By tradition, subsurface disposal is generally acceptable to health authorities. Unfortunately, a large portion of the earth's surface is simply not well adapted to soil absorption. Thousands of persons have bought homes on lovely suburban sites, or built recreational homes in the wilderness, only to gasp in dismay as their plumbing backed up within a few months. The owner has two solutions: sell—often impossible after word gets around; or, regard his septic tank as a holding tank and call the "honey wagon" every few weeks.

The disposal problem. Some avid fans of aerobic systems contend that the effluent may be safely discharged on the surface or into a stream without hazard. With an additional step of chlorination (aerobic treatment does not destroy pathogenic organisms) this may be true. But this is exactly where a great many public health people beg to differ. The authorities have some excellent arguments:

- Few home owners can monitor effluent quality scientifically. Who knows what's being discharged? Public officials lack time and money for constant surveillance.
- Mechanical plants are not "fail-safe." A power failure or shock load of concentrated wastes may upset operation of a system.
- Americans tend to be casual about the operation of mechanical equipment. If an aeration pump failed, most women would wait until their husbands could see to it.

None of these arguments can be totally refuted. One practical answer seems to be a service maintenance contract with a local representative of the package-plant manufacturer. Reputable sellers of package plants may insist on this, and costs may run from $35 to $75 per year for periodic visits.

Nevertheless, if it is true that an aerobic plant can reduce the soil-absorption requirement to one-third that needed for a conventional septic system, it means that a great number of marginal locations become practical even when soil absorption must be used. According to Dr. Nina I. McClelland, of the National Sanitation Foundation, aerobics are the "answer to a prayer" in Hawaii, where the substratum is lava rock.

What you're bargaining for. What would you get if you ordered a package-type aerobic plant? Many consist of hopper-like metal or concrete structures about the size of a pickup truck box (but deeper) complete with motor and working parts. Size, of course, must match family needs. Normally, this would range from 500 to 1,500 gallons. Installation consists of digging an adequate pit to bury the unit, a trench and pipe to your house, and an electric cable to supply the motor. Other types have no moving parts out in the yard. They resemble a large fuel-oil tank and contain water-transfer pumps that operate on air columns.

Inside the house, you would have a small control cabinet with the necessary timer, compressor, and automatic controls. Whatever the system used, you'd normally pay about as much attention to it as to a refrigerator. In fact, manufacturers frown on do-it-yourself adjustment and maintenance.

What does it cost? Depending upon such things as whether you can have a precast concrete tank fabricated locally, labor rates, size, and the like, it will cost between $500 and $700 for typical aerobic equipment. Obviously, excavation of the tank pit, connection trenches and pipes to the house, plus

[Continued on page 138]

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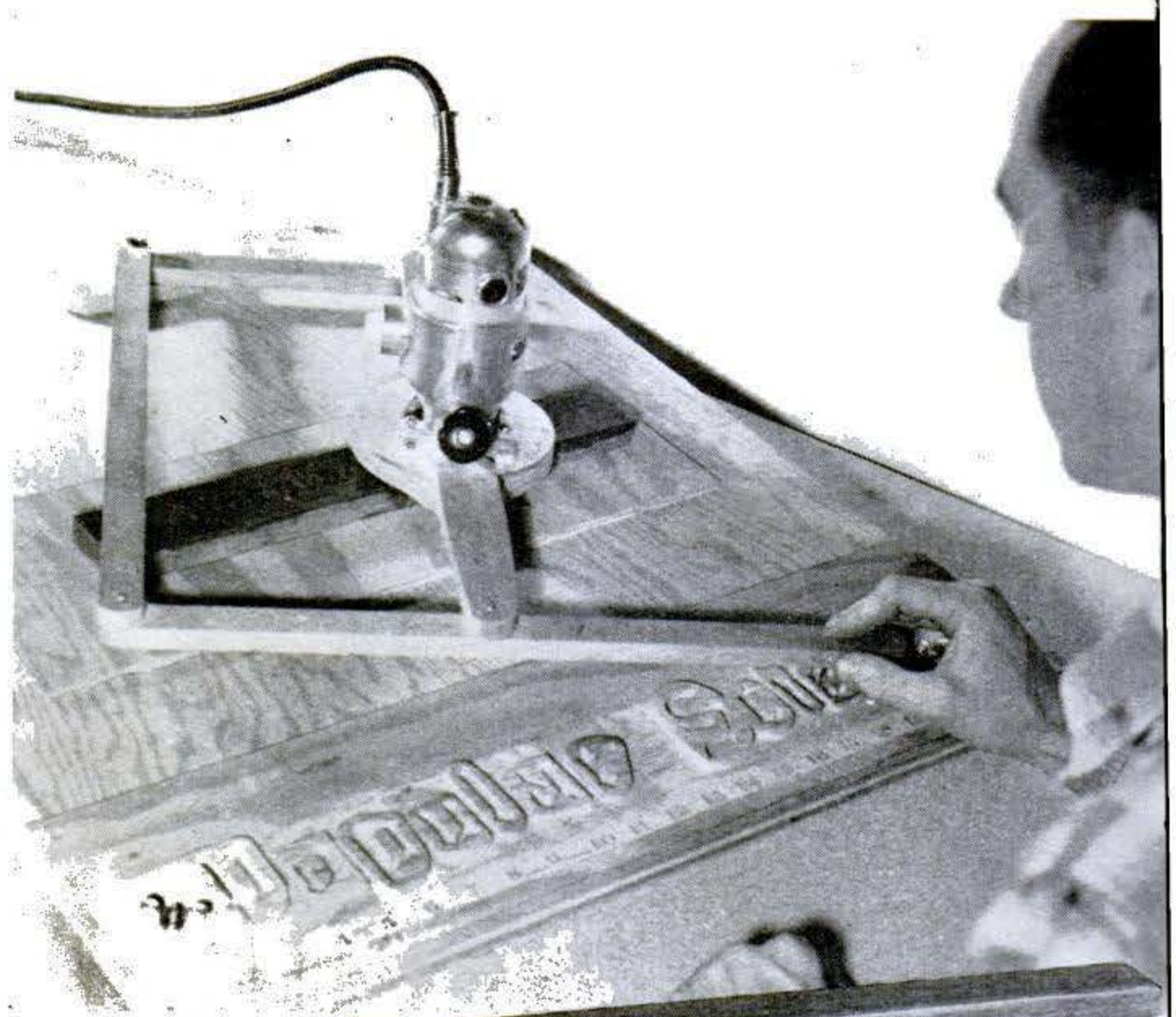
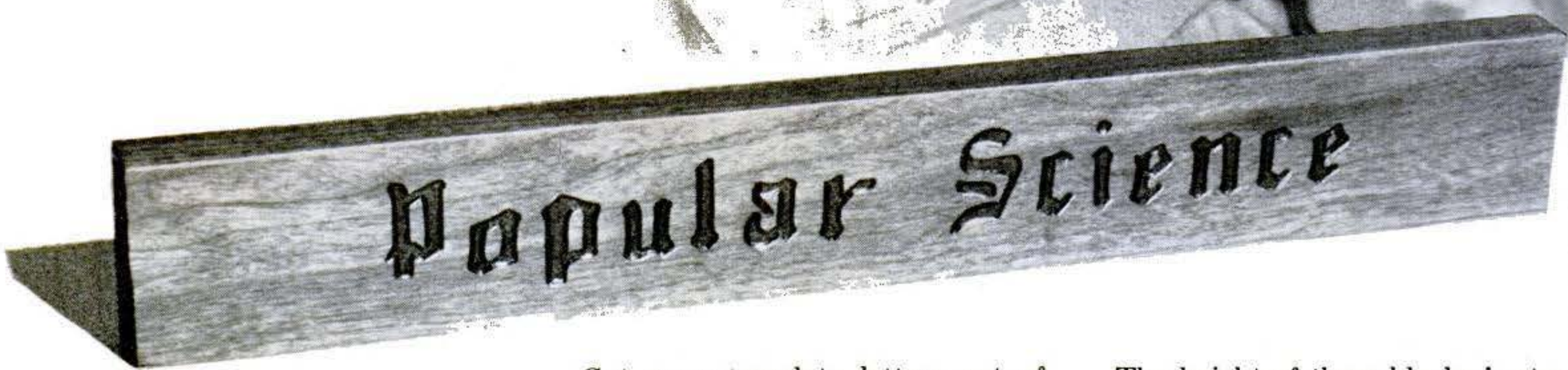
Make a Pantograph for Your Router

Recessed-letter signs are a cinch to make with this device plus homemade alphabet templates





By JAMES A. JOYNER

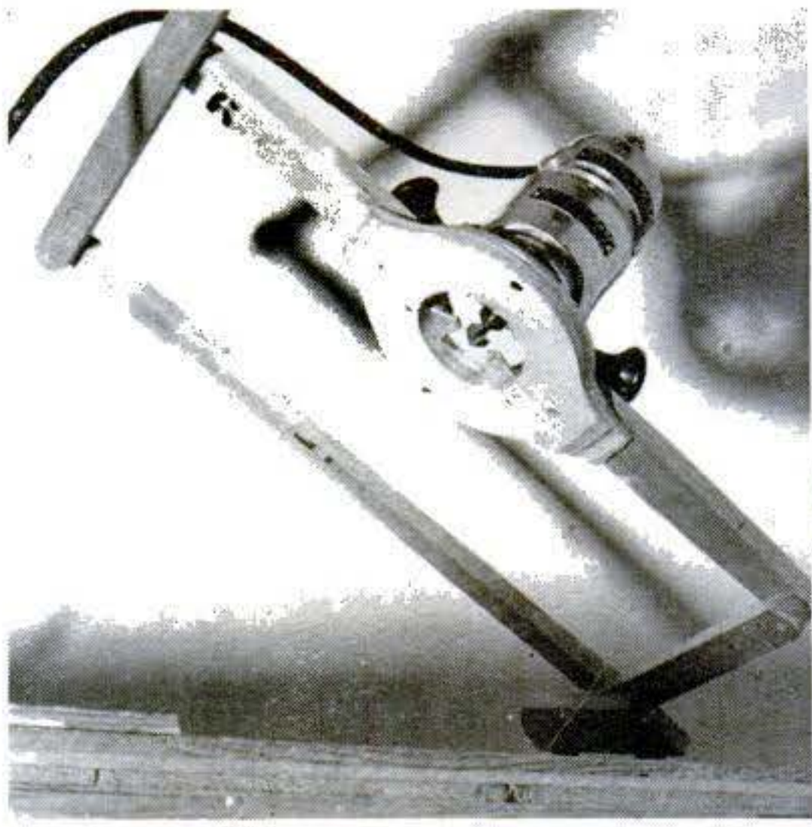
Ever watch a jeweler engrave a nameplate? That's what gave me the idea for this simple pantograph for my router. Now I turn out desk plates, mailbox signs, and house numbers—in walnut, oak, or virtually any material that can be worked with a router. The hand-carved look makes these signs much appreciated as gifts; they could even be a profitable sideline for a home shop owner.

The hardest part of making the rig is creating a set of templates—especially if you choose a fairly complicated alphabet such as the Old English one shown here.

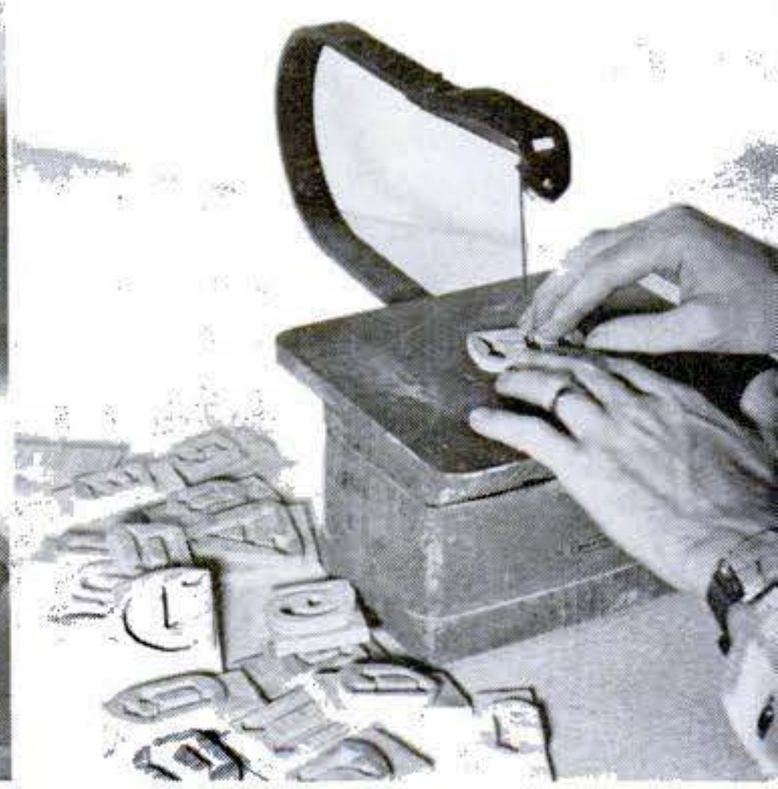
Your choice of alphabets. For the simpler ones, you have your choice of many sources. Art stores sell sheets of rub-on transfer letters in many styles and sizes. Pattern houses offer tracing sheets of various alphabets. You can also consult typographical sample books or sign-painters' guides. If none of these offer the letters in the size you need for the templates (twice the size of the finished letter), it's a simple matter to have them blown up by a photographic or photostat process—or do it by hand on graph squares, as indicated here.

Cut your template letters out of ¼" plywood or hardboard, saving cutout center pieces you'll need later. Keep in mind when guiding the saw that it's the letter itself you want to cut away, leaving a perfect piercework outline of it, as in a stencil. When this is done, cut around the letter, trimming no closer than 3/16" to its right and left sides. Now glue the stencil letter on a backing block of the same material, with top and bottom ends of the block beveled 20 degrees, as sketched above, right.

The height of these blocks is standard, but the width depends on the width of each specific letter. Cut them ⅜" wider than the stencil cutout and glue the letter on so as to leave 3/16" between the edge of the block and the edge of the letter. This makes letter-spacing automatic when the blocks are assembled to form a word or name. The bottom of all letters should be the same distance from the bottom bevel of the blocks. If your stencil cutouts are made to the dimensions shown on



Tipped back on hinge, rig shows how V-groove (chamfer) bit projects below router yoke. Adjust depth to set single-pass line.



Letter templates are cut from ¼-inch plywood or hardboard, using jig saw or coping saw, then glued to beveled blocks.

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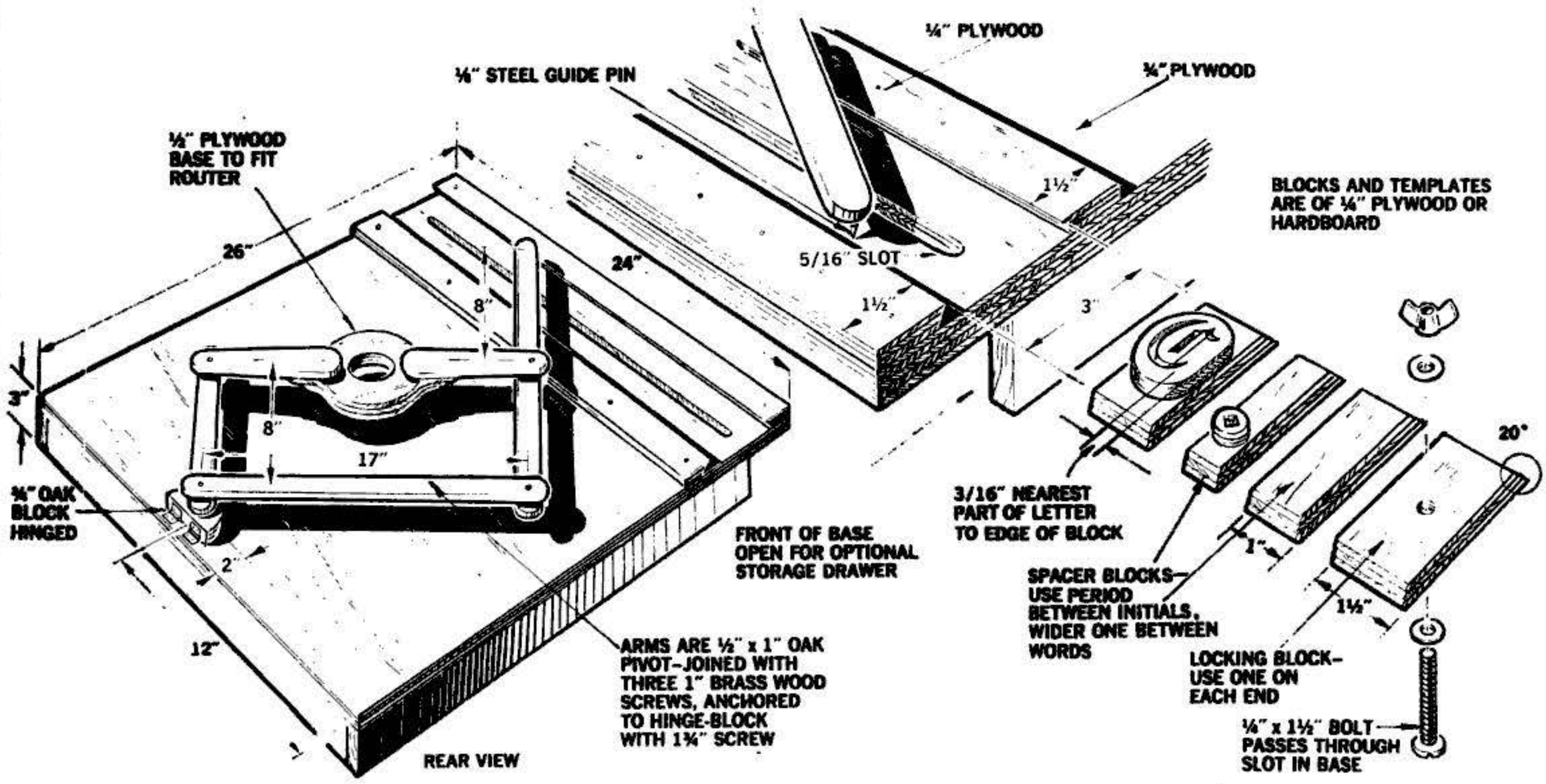


ABCDEFGHIJKLMNOPQRSTUVWXYZ
abcdefghijklmnopqrstuvwxyz &!?1234567890

the graph squares at right, the routed capitals will be an inch tall.

Pantograph goes together easily. It will, that is, if you follow the plan carefully and make no changes in dimensions. Cut the arms from ½" oak; don't use any other material or you'll be disappointed. The self-lubricating quality of oak allows for snug pivots, yet permits smooth action. Tighten the brass pivot screws so that play is eliminated without putting a drag on the pivot.

The router platform must be adjusted to fit your tool, but that presents no problem. Any router can be used—just keep the overall length of that platform arm the same. Note that dimensions of the arms are from pivot to pivot.

The table of the pantograph is ¾" plywood. I tucked a drawer underneath mine to store my templates. The template guide strips are ¼" plywood attached to the face of the table with glue and brads. I also glued a section of a discarded measuring tape along the edge of the lower guide, as shown in the top photo.

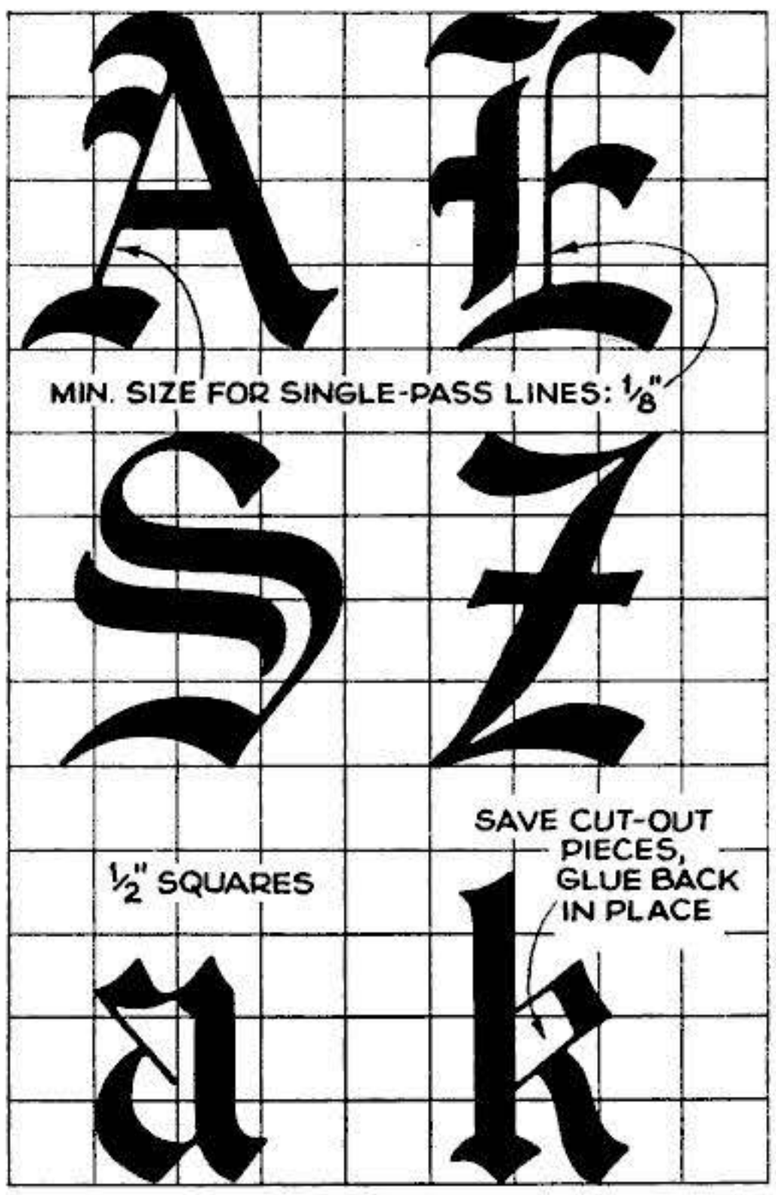
To rout letters in other than flat stock, you'll have to cut a hole in the pantograph table and fashion a temporary jig to hold the object in place. In any case, the surface into which you're cutting must be no less than ¾" and no more than an inch above the top surface of your work table.

When operating the pantograph, be sure to lower the guide pin into the template before the router bit cuts into the workpiece. This eliminates costly errors. Practice on a scrap block so you'll know exactly where to anchor the work on the table to center the routed letters on it. You'll soon get the knack of tracing the guide pin around the outline of each stenciled letter, and of removing wood with repeated passes.

The only satisfactory cutters are the common V-groove or chamfering bit or the 1/16" carving bit. By adjusting the cutting depth of the former, you can set the best width for single-pass lines; this bit also gives the cut an angled side and textured bottom that adds to the appearance.

To finish the signs. The one shown on the opposite page was sprayed with flat black enamel, after routing, then sanded smooth with fine paper wrapped around a block. This removes all enamel from the surface of the wood but leaves the routed letters in a crisp contrasting black. Then you apply an overall natural finish such as Minwax Antique Oil, to bring out the beauty of the grain.

An alternate finish reverses the steps. Spray on an enamel *before* routing and cut through it, leaving the letters unfinished.



Two-inch templates shown above give you finished letters 1" high. For other letter sizes, just make templates twice as large.

The size of the workpiece can be adjusted to the height of your letters and the length of the name. The sample shown is a solid piece of walnut ¾" thick, 2" wide, and 15" long. That's an ideal size for nameplates for an office door or desk. PS

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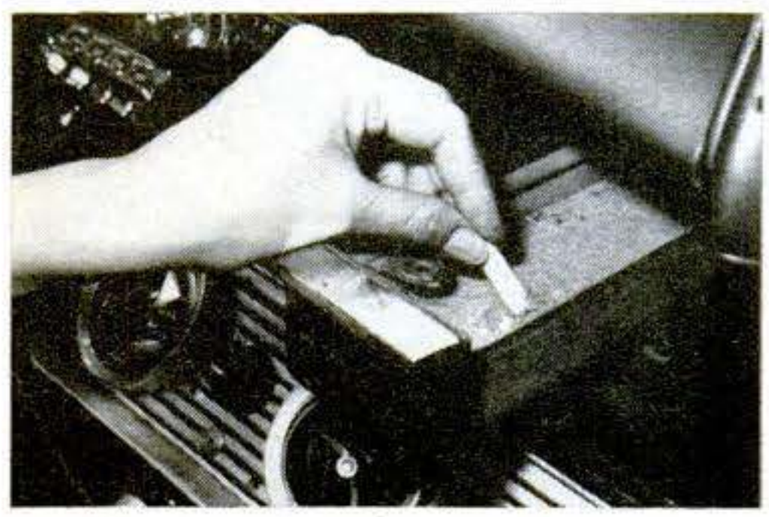
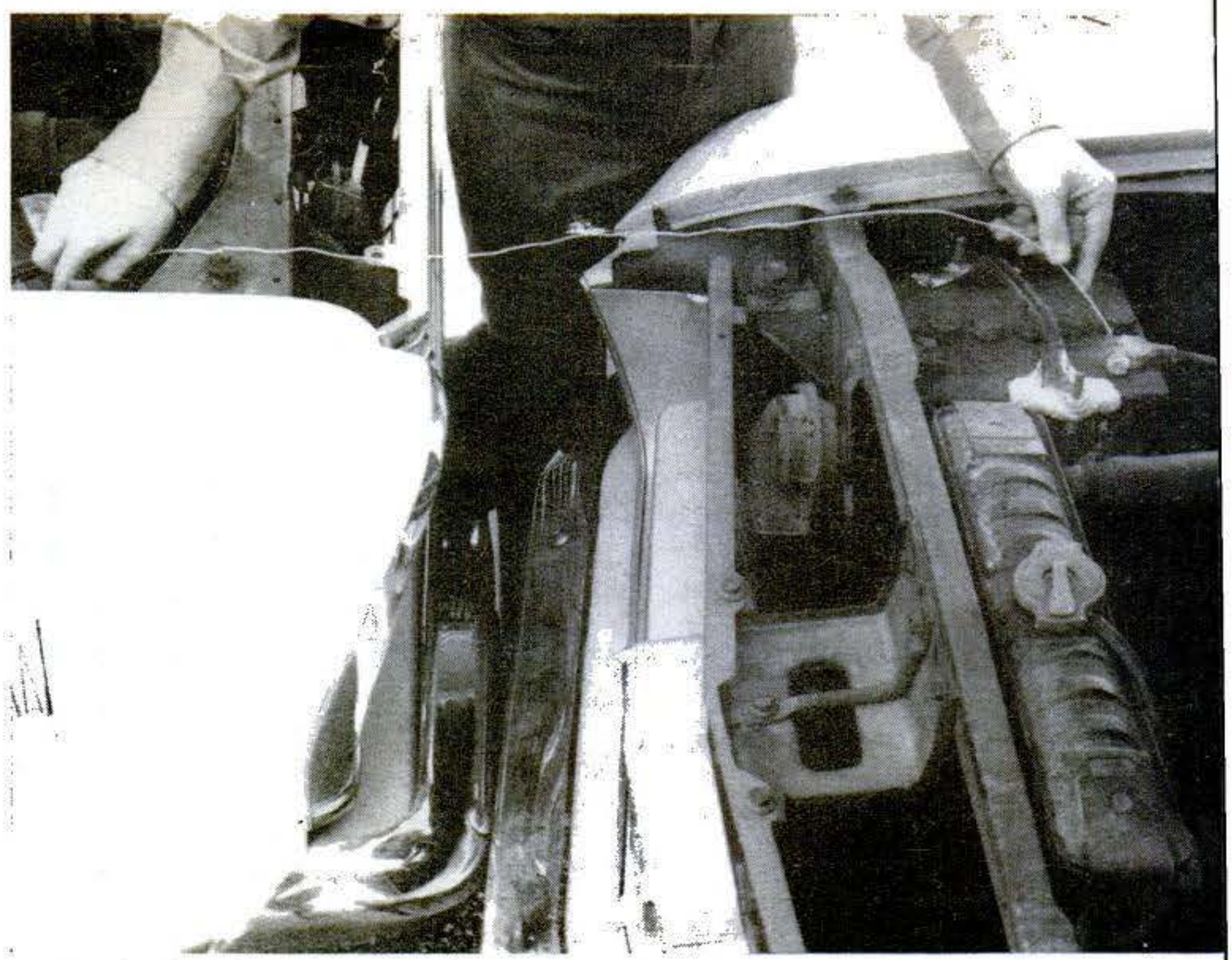
Taking Care of Your Car

Good hints others have used

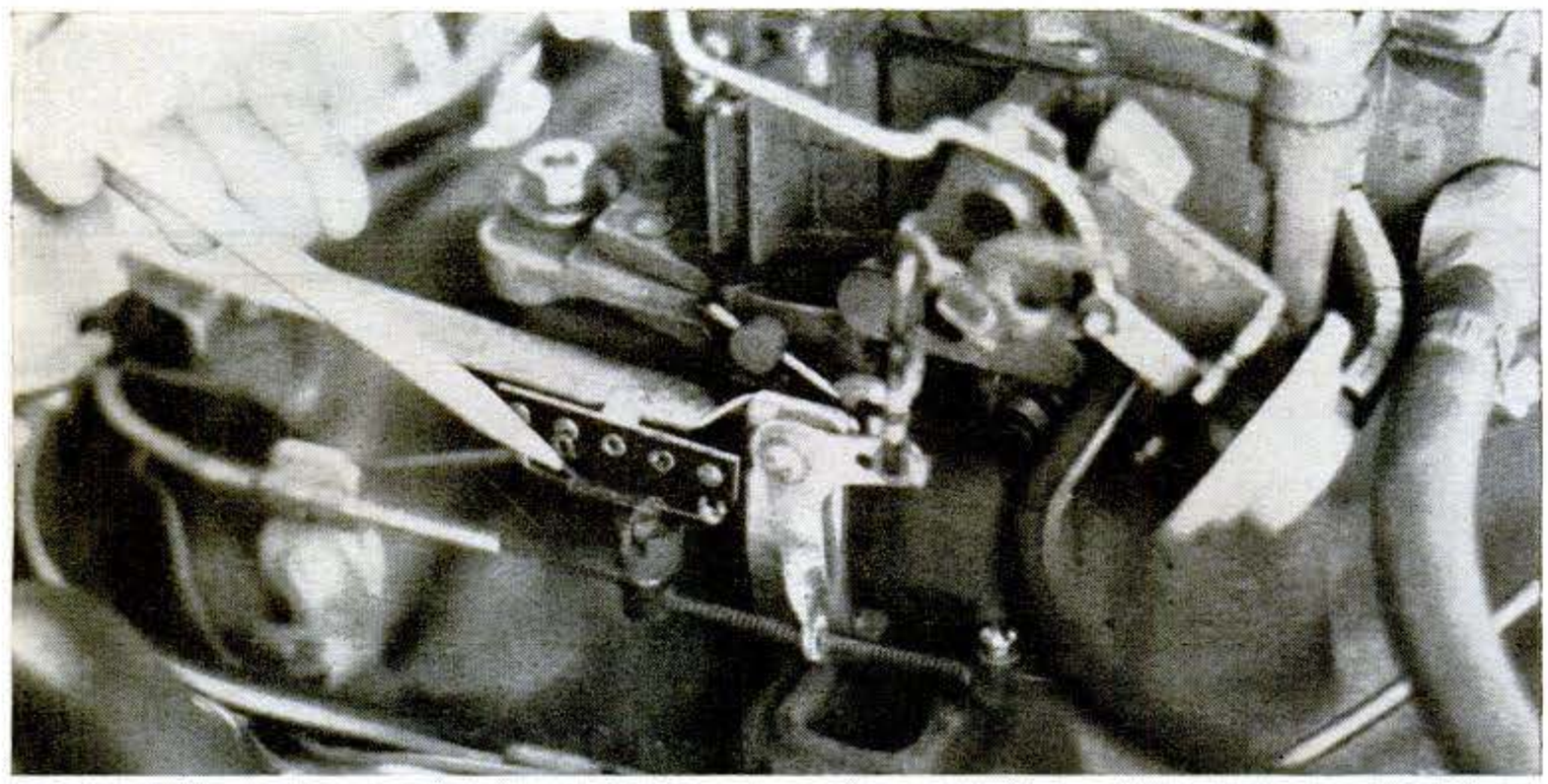
Got a car tip? We pay $25 for each one accepted. Send it to Car Care, POPULAR SCIENCE, 355 Lexington Ave., New York, N.Y. 10017. None are returnable.



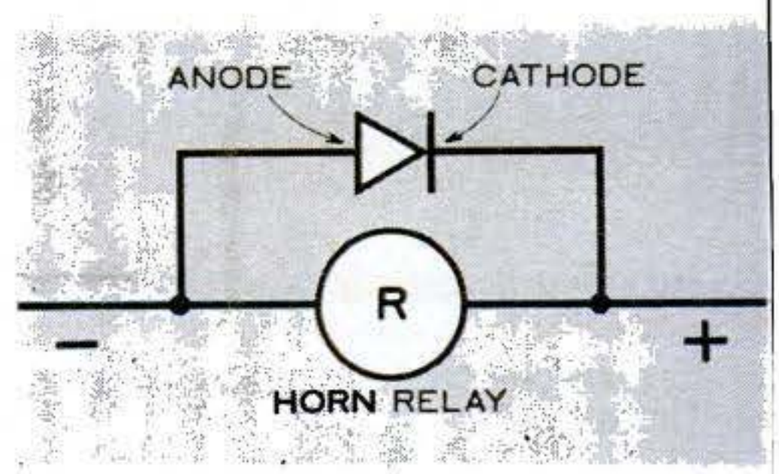
Smoldering and stinking cigarettes in ash trays are eliminated if you partially fill the bottom with sand. The sand puts out the fire, and cleaning is easy: Just shake the trays until the butts surface.



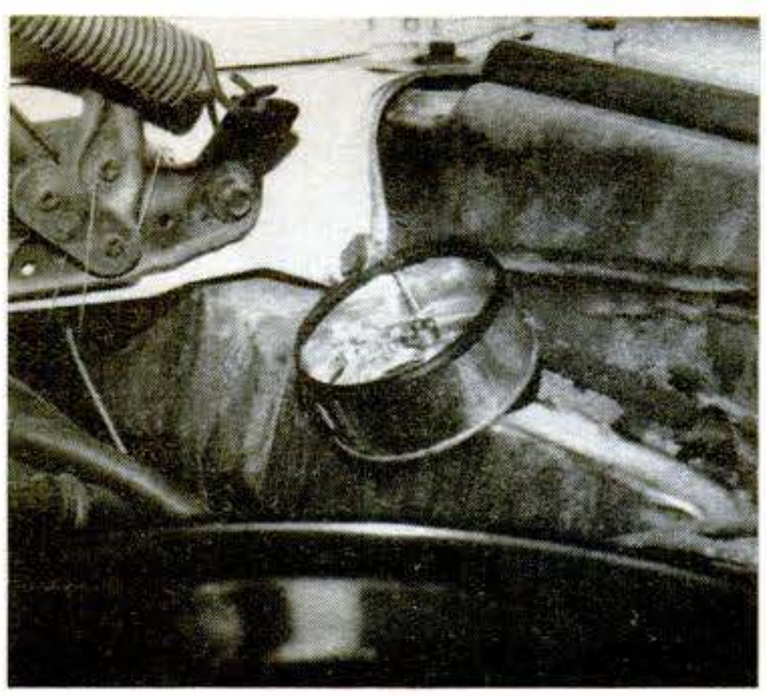
Battery dead and no jumper cables? Get another car of the same voltage and polarity as yours to pull up to yours until the bumpers contact solidly and complete a ground connection. Leave the engine running in the second car. Hook the hot side of the two batteries together with any available scrap of wire. Wait 15 minutes, then disconnect. Your battery will now have enough charge at least to start the engine.



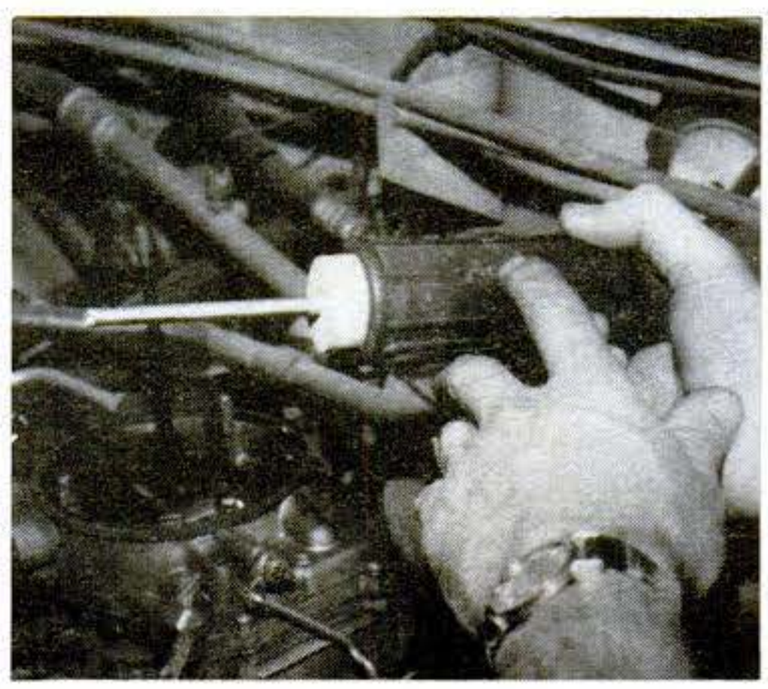
A helpful reminder light to indicate that your manual choke is not fully open can be made from a magnetic reed switch actuated by a magnet attached to a collar on the choke cable. Wire the switch to a pilot light on the instrument panel.



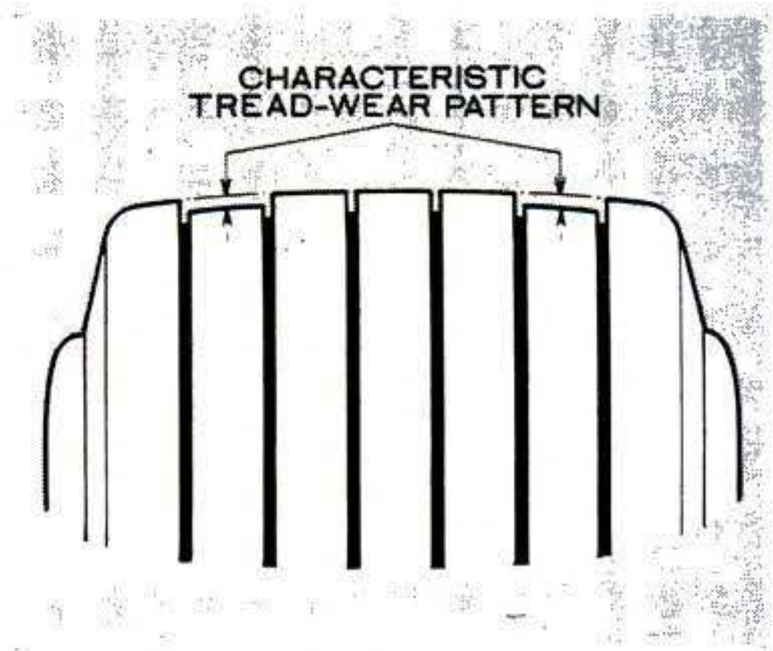
Get a shock from the horn ring? Don't tear the whole wheel assembly apart. Just place a diode across the horn relay coil as shown. Use a diode with a minimum PIV rating of 600V, e.g. IN3254. Place the cathode on the positive side of the relay.



Need a stowage spot for those odd nuts and bolts that might drop when you're working on your car? Attach a small, powerful magnet with a blob of contact cement to the bottom of a shallow tin can.



When cleaning preheating passages of a carburetor, there's risk of carbon dropping into the engine. To prevent it, insert steel tubing, notched at the end, into a wood plug to fit your vacuum cleaner hose.



Noticeably uneven wear on belted bias-ply tires is sometimes normal. If the two tread rows next to the shoulder ribs show more wear than the rest of the tread, don't worry. Be reassured by the fact that this type of tire is supposed to wear in just such a pattern, and it does not shorten the life of the tire tread, nor is it any indication that wheel alignment is faulty. Inflation pressure should not be changed from the manufacturer's recommendations.

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America will host 1500 marksmen from all over the world.

To: N.R.A. World Shooting Championship Fund
1600 Rhode Island Avenue, N.W. Washington, D.C. 20036

I am delighted to help. I enclose a check or money order for:

☐ One to five dollars—for which I will receive:
( ) A Bumper Sticker
( ) Two 40th World Crest Decals.

☐ Five dollars or more—for which I will receive:
( ) A handsome Embroidered Emblem of the 40th World Crest, or
( ) A 1¾" Bronze Medallion bearing the Crest.

☐ Twenty-five dollars or more—for which I will receive the Medallion mounted on a handsome inscribed plaque.

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CITY_____

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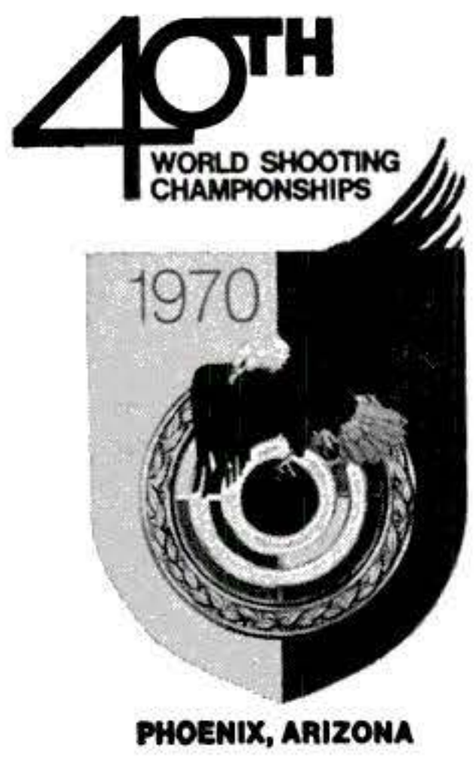
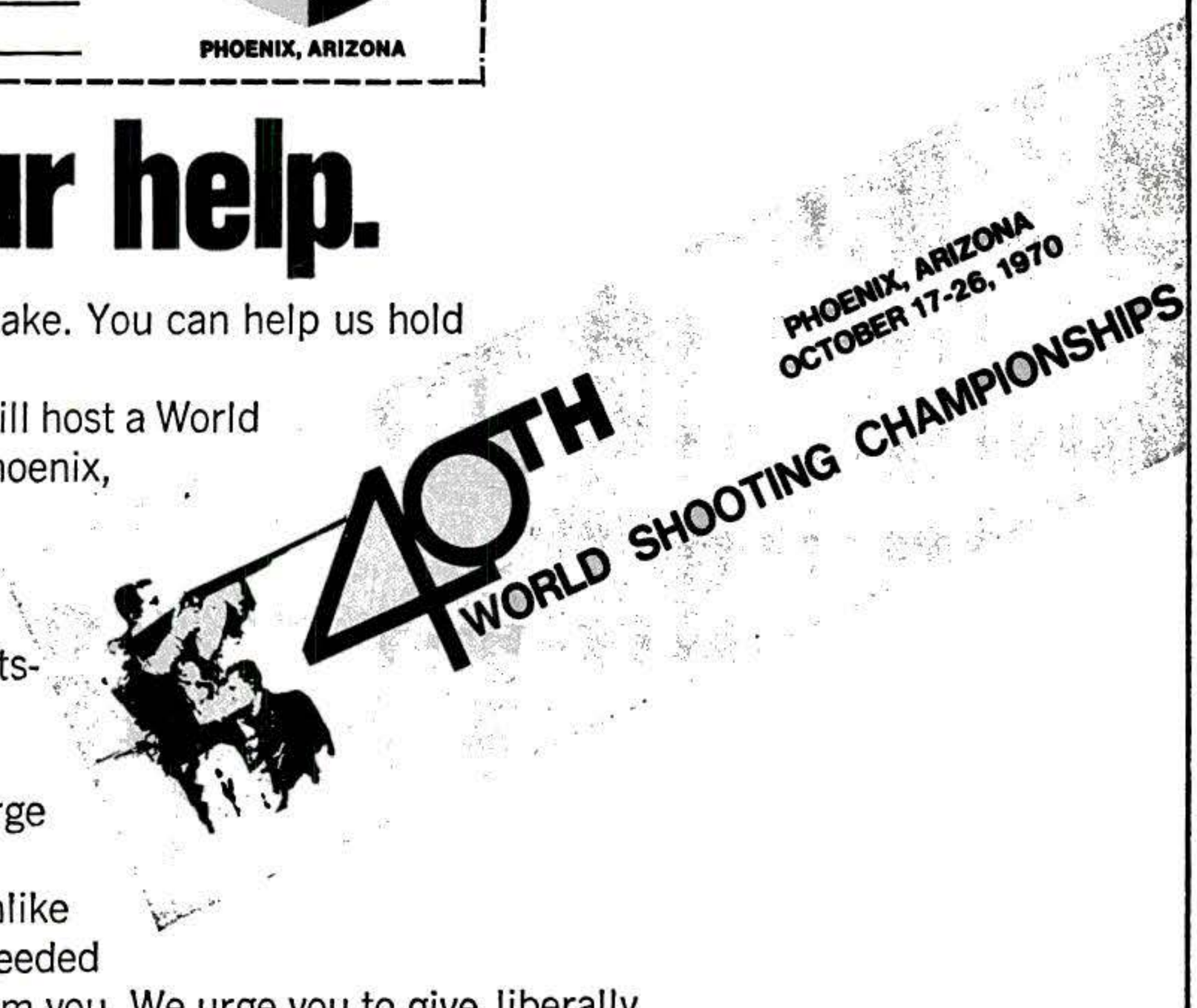


With your help.



Our country's pride is at stake. You can help us hold our heads high.

This October, the U.S. will host a World Shooting Championship. Phoenix, Arizona is the scene, as 1,500 gold-medal marksmen from over 90 nations compete in contests of sportsmanship, timing, and skill.

It takes a lot of money to sponsor and host such a large event. And to field a team that will shine in sportsmanlike competition. Much of the needed money we get will come from you. We urge you to give liberally, and maintain this country's prestige in international sports.

Your donation, whatever the amount, will help greatly. And if you contribute $5.00 or more, we'll be pleased to send you a commemorative Embroidered Emblem or Bronze Medallion. For a donation of $25.00 or more, you'll get an attractive donor wall-plaque.

Please fill out the coupon, and give now. Help us perpetuate competitive shooting as an international sport for years to come.

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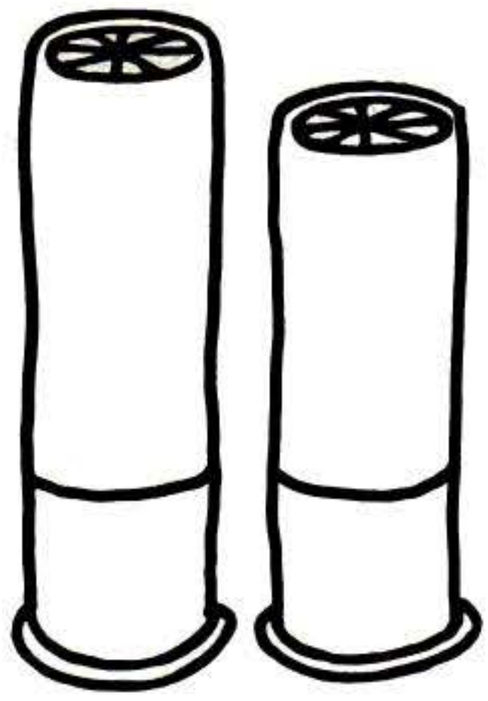


Magnum Chambering

Consider it part of the "$40-Bonus" you get with a Savage 30.

Heft the newest version of a Savage 30 slide action.

You've got an honest-to-goodness $151.75 shotgun in your hands.

Now if you wouldn't hesitate at that price, imagine how you'll act when it's offered to you for $111.75.

Because that's the regular price.

How do we do it? Simple. *The Savage 30 has every deluxe feature you want built right into the price.*

Other slide actions offer our deluxe features as extras. Then charge extra. As much as $40 extra. (And who needs that these days?)

But you know that Savage is the gun specialist. With us less money doesn't have to mean less gun.

Let's be specific. Take magnum chambering. It's vital if you really want to reach out. *All by itself magnum chambering costs up to $20 extra on competitive guns. It's standard on the 30.*

Take interchangeable barrels. So important to the man who likes his hunting varied, but his "gun feel" the same. The Savage 30 is designed for him.

The Savage 30 will take seven popular chokes and barrel lengths. If you're out for quail and woodcock, for example, you might like a 26" barrel, improved cylinder. If you're hunting ducks or geese, there's a 30" full choke. Suggestions only. Please yourself.

The barrels change in seconds. The fast takedown feature makes cleaning and transporting easy. Everything's simple, period.

Now let's get a look at the top of those barrels. You know all the talk about ventilated rib. Gotta have it. Right? The Savage 30 has it. *And we don't charge you $20 extra for it either.*

A new, superstrong ventilated rib that gives you a faster, surer, single-sighting plane.

More deluxe: Top tang safety. Instant control is right under your thumb. A generous trigger guard, so you won't have any trouble when you wear gloves. And a neat recoil pad.

O.K., features are great. But you also want to have confidence in the basic gun.

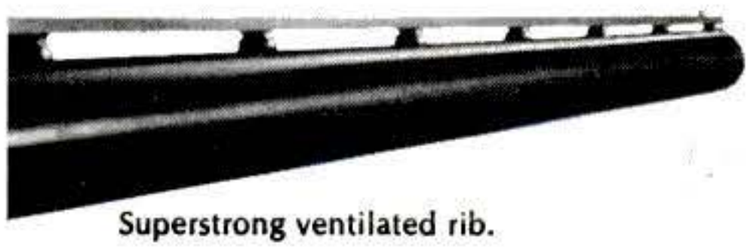
Have confidence.

At Savage we pick our metals to match the job the gun has to do. For *the 30 we chose a solid 8¾ pounds of RR "A" steel and machined it down to less than two pounds of receiver.* We kept the bearing surfaces at the critical lockup points massive, then heat-hardened the mating surfaces between the receiver and the bolt.

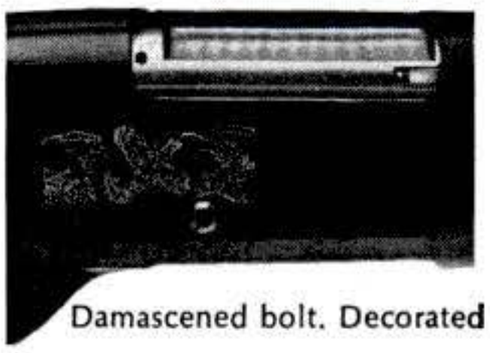
Any questions about how strong the lockup is?

Next we gave the receiver a high polish that accepts a beautiful blue. And, for the final deluxe touch, decorated the receiver with a game scene.

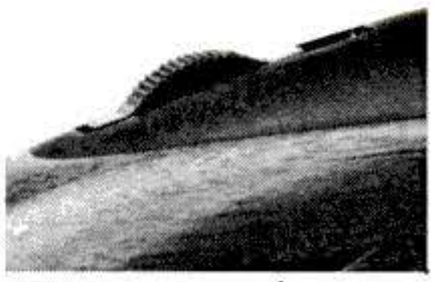
The action of the 30? Smooth and



Superstrong ventilated rib.



Damascened bolt. Decorated receiver...



Top tang safety.

Interchangeable barrels, including new 12 ga. slug barrel with folding leaf rear sight.

American walnut stock; recoil pad.

Less money doesn't have to mean less gun...

Prices subject to change. Slightly higher in Canada. Savage and the Indian Head are trademarks of Savage Arms, Westfield, Mass. 01085. Div. of Emhart Corporation,

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lightning fast, so important when you're swinging on a double.

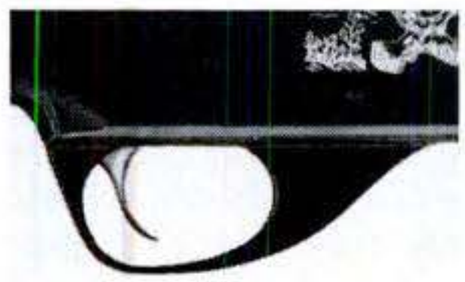
And the stock is handsome American walnut, with checkering along the pistol grip that is as functional as it is nice to look at. A durable finish enhances the grain while it provides the field protection a shooter wants.

The Savage 30 is available in 12 and 20 gauge, chambered for 2¾" and 3" magnum loads. Also, 410 gauge chambered for 2½" and 3" loads. For trap shooters, there's the 30-T (at $118.75) with Monte Carlo stock, recoil pad, chambered for 2¾" and 3" magnum loads.

Compare what the Savage 30 offers, feature for feature, with other slide actions. It's like getting a $40 bonus in deluxe features. Free. For nothing.

Need we tell you you just bought yourself the shotgun you always wanted?

For free 32-page catalog, write: Savage Arms, Westfield 712, Mass. 01085. Please include your zip code.



"Gloved-finger"-sized trigger guard.

Savage

Reg. U.S. Pat. Off. Marca Registrada.

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[Continued from page 58]

labs, film-processing facilities, a cafeteria, and an auditorium. It will be a meeting place for the scientific colony of 2,000 at the Center.

Machine saved from disaster. Behind the Weston colossus lies a dramatic and little-known story: how it was rescued from being crippled by the economy axe—and turned at bargain cost into an even mightier machine than first envisioned.

At first it was not to exceed 200 BEV. Its original design was completed in 1965 for the Atomic Energy Commission by the famed Lawrence Radiation Laboratory of the University of California. The estimated cost: $350 million.

At sight of this price tag, the Bureau of the Budget threw up its hands. Back came the crushing dictum that the cost would have to be slashed to within $250 million.

Sadly, the experts concluded that, while the 200-BEV energy could be kept, the "intensity"—the number of protons delivered per second at that energy—would have to be drastically reduced. Observers would have to wait much longer for lucky target hits to yield the rare particles or unusual happenings in which they were particularly interested. Some experiments involving the rarest one would be simply out of the question.

When Congress heard the plans for what the AEC now called a "reduced-scope accelerator," critics found harsher names. A "poor man's accelerator" was one. "You came in here and sold us a 16-inch gun. Now we are getting a .22-caliber rifle," a congressman complained—and was not mollified when an AEC spokesman replied it was not the caliber but the rate of fire that faced curtailing.

But the great machine was to be saved from its threatened downgrading, principally by one man. He was the National Accelerator Laboratory's newly appointed director—Prof. Robert R. Wilson, brilliant Cornell University physicist. Then 53, he would be spending a good part of his life with the Weston accelerator—and was ready to battle for the best that a quarter-billion could possibly buy.

Racing a 1967 AEC deadline less than four months away, Prof. Wilson led a team in redesigning the atom smasher. Bold innovations cut its cost to the required limit without sacrificing its intensity.

A bargain new design. Big proton accelerators had always used the same magnets to bend the beam in a circle, and to focus it. By introducing "separated-function" magnets —some for bending, some for focusing—Prof. Wilson simplified their design and scored a substantial saving.

He shrank the cross section of the main-ring tunnel—another big cut in expense—by eliminating overhead cranes to install the magnets, in favor of magnet-handling vehicles.

Savings like these enabled him to bring off an audacious coup—building a 200-BEV machine that only a little alteration could later boost to 400, even 500, BEV. The ring and its magnets would be big enough at the start; for 200 BEV, the magnets would run at half power. Comparatively modest and simple changes, like enlarging the magnets' power-

Vacuum-tube "gun barrel" for protons takes these varying shapes. Largest has an overall size of two by five inches.

A lot of people who aren't impressed by the price of our cigars are impressed by our cigars.

A lot of people who can afford to smoke more expensive cigars smoke Roi-Tan.

Because to them, it's not the price that makes a cigar good. It's the tobacco.

Roi-Tan is a blend of fine imported and domestic tobaccos, and if you give one a chance, we think you'll be impressed by how good it tastes.

So impressed you'll forget about how little it costs.

ROI-TAN *Falcon*

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upply and water-cooling systems, ould suffice to go to top energy.

His revamped design met the AEC's eadline and its cost ceiling—and he ot his go-ahead.

Fortune favors the bold—and his nachine, now taking shape, has late- y benefited from an unforeseen break. Because of recent advances in the echnology of thyristors, the recti- iers to power the magnets, a 500- BEV power system could be had for ess than a 200-BEV one had been xpected to cost—and Prof. Wilson nappily built it into the machine.

Consequently, he now surprisingly eveals, the machine may reach top 500-BEV energy at start-up or soon after. About all still lacking is in- creased cooling for the magnets; ex- pedients such as operating on cool days can get around that. Pending completion of the experimental area— which will take longer than readying he machine itself trials can be con- ducted by tucking temporary targets ight inside the main ring.

What experimenters will seek. One major aim of the new machine's isers, Prof. Wilson says, is a quest or the ultimate secret of what mat- er is made of—the fundamental particles within the almost inconceivably small nucleus of an atom.

A great accelerator serves like a microscope to peer into this subatomic world. Paradoxically, the smaller the details that observers want to see, the larger the accelerator must be. Raising its energy is like increasing the resolving power of a microscope. Hence, progress in learning about the atom's insides goes hand in hand with bigger and bigger accelerators.

Back in the 1930s it looked as if the atom's basic building blocks had been found, when protons and neutrons were discovered. Then came mesons, neutrinos, and others to complicate the picture. Today we face a staggering array of some 150 known subnuclear particles—and doubts are growing that they are fundamental, indivisible ones.

"We believe," says Prof. Wilson, "that there must be an underlying simplicity—perhaps three particles or something of that kind—that will make what is now so complex turn out to be very simple."

Hunting the elusive "quark." By one current hypothesis, protons and neutrons and other particles may be clusters of "quarks"—still-undiscovered sub-particles, with fractional electric charges, detectable only by the mightiest atom smashers. Soviet experimenters have been quark-hunting with their 76-BEV machine, with no reported success up to this writing. Some think it will take more power—the kind of power that the Weston machine will wield.

Experiments possible only with the new machine, Prof. Wilson observes, will also give the first definitive information about the most mysterious of the four forces in the universe. Three are familiar: gravity, electromagnetic force, and nuclear force. The little-understood fourth—a so-called "weak" force—causes the radioactive decay of beta-ray-emitting nuclei and of some newfound, short-lived subnuclear particles.

Can this pure-science researching have any practical, down-to-earth results? Studying the nuclear force with earlier accelerators led to the sensational unlocking of atomic energy, Prof. Wilson reminds you. "A deeper understanding of the weak force" he adds, "could be as relevant to our lives as the other forces, in technology that will come from that understanding." PS

LIBERATE AMERICA FROM CREEPING RUST

Meet Rust Patrol. A new and devastatingly effective rust remover.

It's ruthless. Digs down deep for rust and dissolves it completely. But it's selective, too. So it won't remove paint or pit metal. Even works on chrome and aluminum.

Rust Patrol™ rust dissolver comes complete with a free applicator brush. So it's easy to apply. (It even sticks to vertical surfaces.) And when it's done the job, you just wash the rust away—no scraping, no sanding.

Get yourself some Rust Patrol. Nobody wants America to go rusty.

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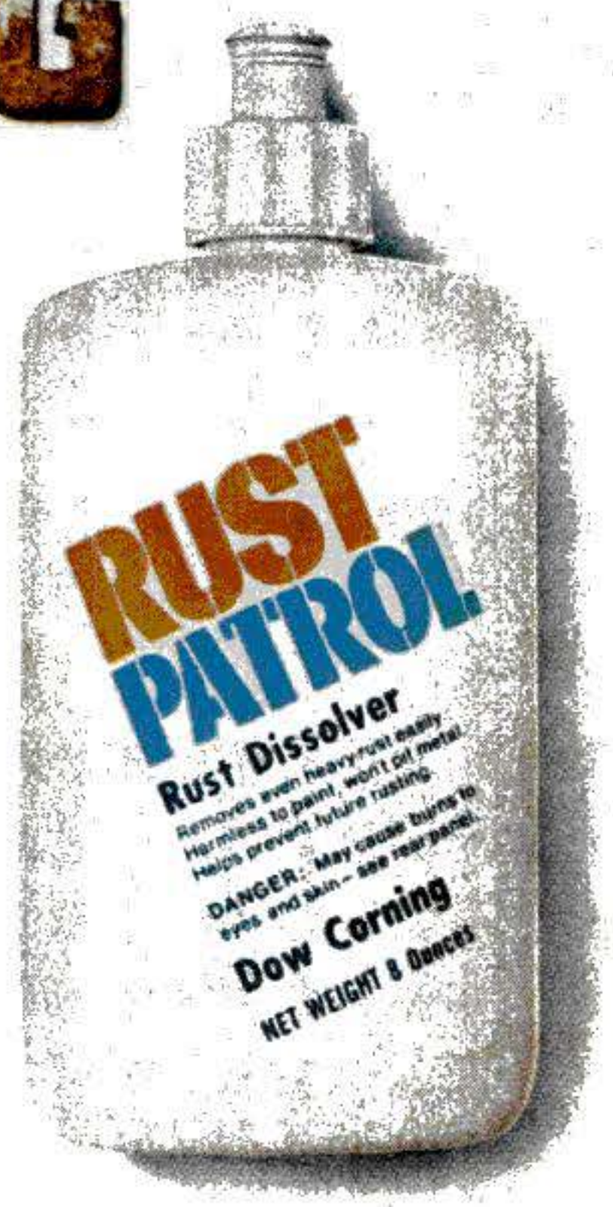

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Here Com

PS previews the newest crop

Polaris Charger offers improvements in its unique Drift Skipper suspension, to make for an even more comfortable ride. There are five engine options—294 to 488cc.

Sporty GT-36, one of Alouette's new family machines designed for reliable performance, leads off at left with XL30W, GT23, and the XL24 behind it.

Yamaha SS 433 features a 40-hp twin with five ports for complete fuel combustion. It also has the exclusive Autolube system that makes premixing of fuel unnecessary.

Canuck Skiroule bows in this year under the Coleman banner. The Canadian snowmobile firm was recently acquired by the famous U.S. maker of outdoor equipment.

Rupp 44 Sprint gives you a high power-to-weight ratio with its big 440cc Rupp Ram-Air engine. Ram-Air is Rupp's term for an exclusive fan-fed air-cooling system.

Scorpion Mark series provides sturdy, economical rigs for ice fishing and other winter fun. They come with engines up to 30 hp, enough for most power needs.

Mercury 250 is the top model in the line. This snowmobile has Thunderbolt ignition and an alternate-firing 439cc twin-cylinder engine that turns out 25 hp.

The Escort is one of two distinct series made by Starcraft. It comes in two track widths—15 and 18 inches—and has five engine options ranging from 280 to 440cc.

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he '71 SNOWMOBILES

-scooters—friskier, quieter, and more fun than ever

Sno-Jet's new Super Jet is a hard-working, stable widetrack that comes with 27-hp Yamaha or 35-hp Hirth. Powerful dual headlights are great for night riding.

Ski-Doo Olympique, probably the biggest-selling snowmobile of all time, has revamped styling. Air scoops in sleek new cowl, redesigned seat mark changes.

SkeeHorse Wide-Trac 30 is Johnson's rugged and reliable family snowmobile. It has new Mitt-Grip starter ring for easier with-glove-on starting of 437cc engine.

By HERBERT SHULDINER

It was only a little over a decade ago that you caught your first sight of a snowmobile chugging over snow. Another five years, and 40,000 dotted the landscape. A brand-new winter sport was on its way. It has been growing spectacularly ever since. This year, 600,000 new vehicles are expected to take to field and trail, putting 1½ million in use.

But the popularity of these rigs has hardly been unanimous. Ecologists, government agencies, property owners, and non-snowmobiling outdoorsmen have been sharply critical of the vehicles and their operators. Their chief grievances: noise, the unauthorized use of private land, and careless driving that results in accidents.

The snowmobile industry has itself launched a campaign to eliminate these complaints and to make their products far safer and quieter. The machines shown here represent a big step in that direction. They are the quietest ever offered. And you'll notice a move to end the horsepower race, too. Some makers have even withdrawn muscle engines (over 440cc) from general use.

Further, the International Snowmobile Industry Assn. has increased its education and research budgets to promote safer snowmobile use and to direct research into the effect of snowmobiles on our ecology. PS

Arctic Cat's Lynx is a budget-priced one-seater. It has a shorter-than-average chassis, but its skis are normal length.

Bolen's TR 440 is a smooth-powered widetrack. Its three-cylinder engine puts out 32 hp at 5,400 rpm. It's one of few snowmobiles with turn signals.

Evinrude's Bobcat E251-M has a twin-port, loop-charging 437cc engine that develops 25 hp at 5,300 rpm. Its new molded urethane track produces a better pattern in deep snow to give the machine improved traction.

350 SS and 500 SST (right) are two of Massey-Ferguson's new quartet of Ski Whiz snowmobiles. JLO engines power both of them: a 336cc for the 350, a 399cc for the 500 SST. The vehicles are the quietest ever produced by this snowmobile maker.

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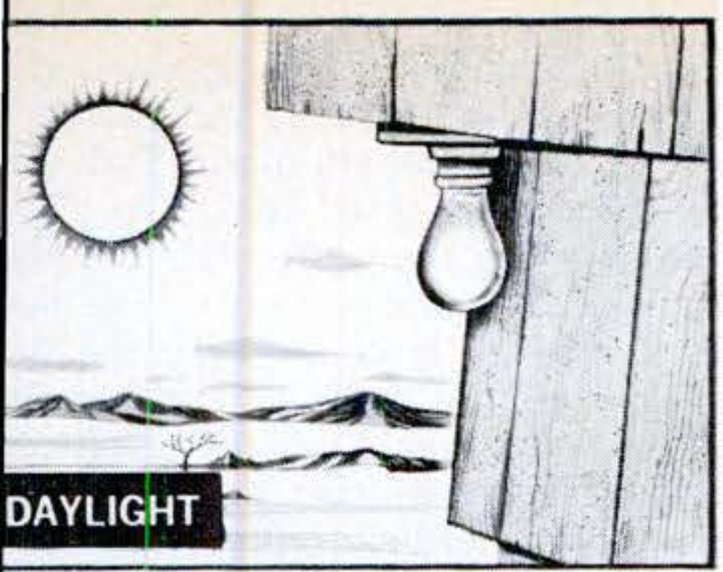

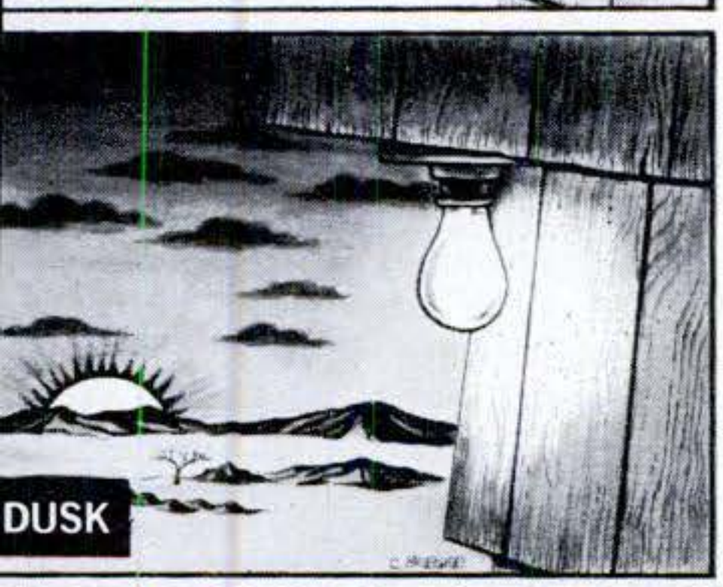

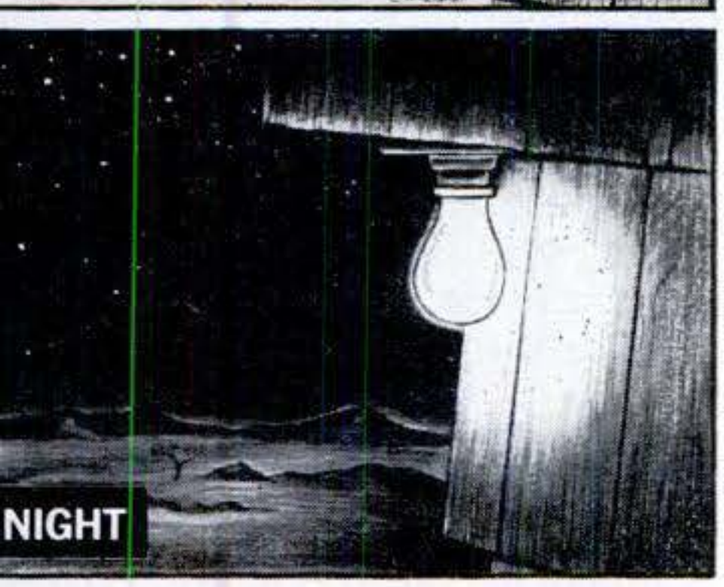

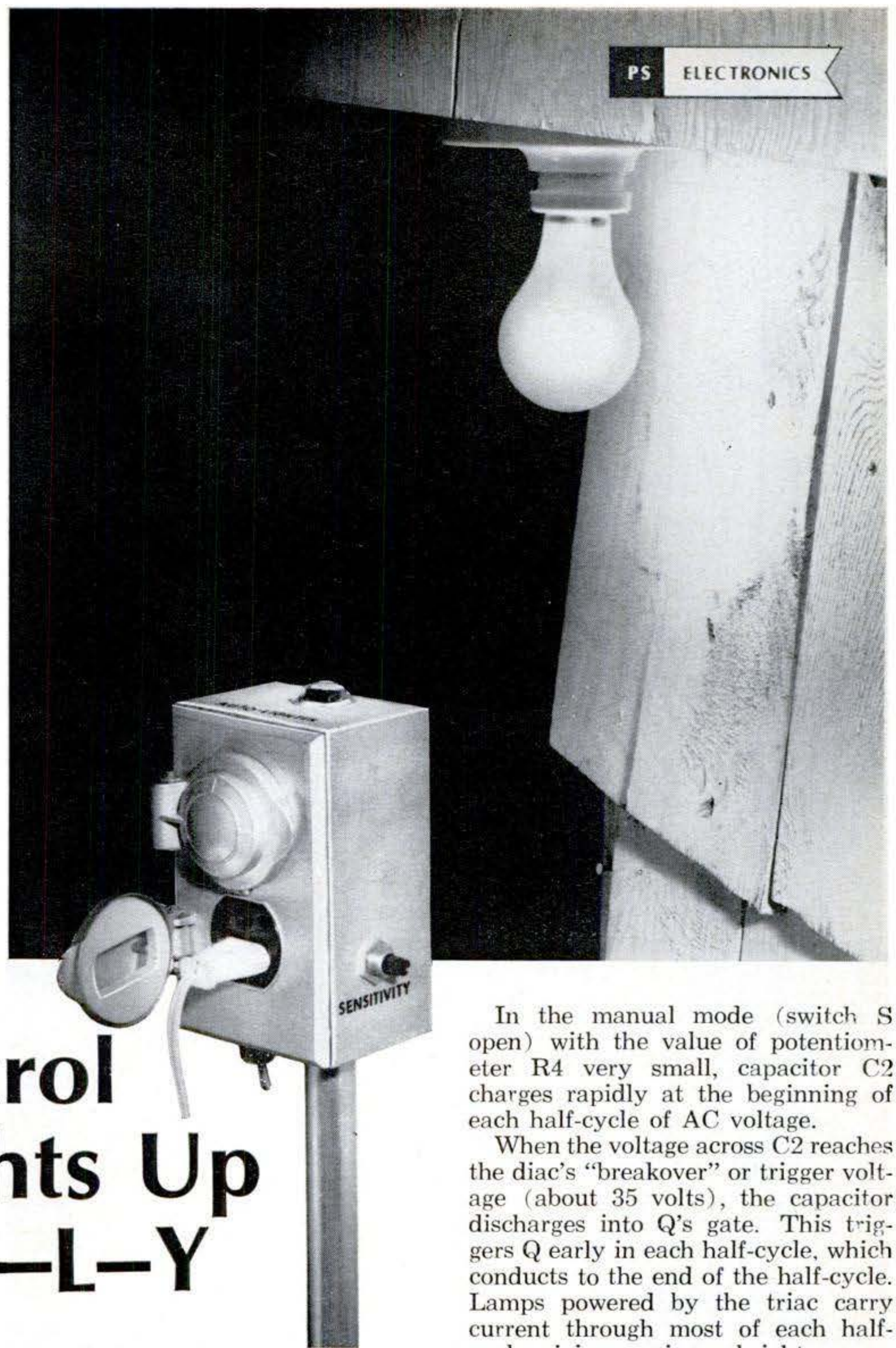

Patio Control Brings Lights Up S–L–O–W–L–Y

asy-to-make control matches intensity of your utdoor lights to the sun's fading glow

JAMES G. BUSSE

unset. You're relaxing on your tio as it begins to grow dark. Sud-nly your outdoor lighting flares on full intensity, spoiling your en-yment of a beautiful sunset or the gering autumn twilight. An elec-onic light control can be convenient, t not very subtle.

Here's what happens if you own a ntrol like mine. As sunlight fades, ur lights begin to glow softly, grad-lly increasing in brightness as darkness falls. If you prefer, a switch and potentiometer let you control the lighting to fit your mood.

How it works. Key solid-state circuit elements are a triac that can handle a 500-watt AC load, a diac, and a photoresistor. Triacs operate like two silicon-controlled rectifiers (SCRs) parallelled in opposite directions with a common gate. Unlike SCRs, triacs control current in both directions through their terminals. In the patio control, the amount of current flowing through triac Q is determined by diac D, a bilateral trigger diode.

In the manual mode (switch S open) with the value of potentiometer R4 very small, capacitor C2 charges rapidly at the beginning of each half-cycle of AC voltage.

When the voltage across C2 reaches the diac's "breakover" or trigger voltage (about 35 volts), the capacitor discharges into Q's gate. This triggers Q early in each half-cycle, which conducts to the end of the half-cycle. Lamps powered by the triac carry current through most of each half-cycle, giving maximum brightness.

As you increase R4's resistance, the time required to charge C2 to D's trigger voltage also increases. Now Q is triggered later in each half-cycle, reducing the time current flows in the lamp load, which dims the lamps.

On automatic: When S is closed, photoresistor R5 is added to the circuit. In daylight, light falling on R5 lowers its resistance enough to prevent the voltage across C2 from reaching D's trigger voltage. As darkness approaches, R5's resistance gradually increases and C2 begins to fire the diac and trigger Q with increasing frequency. By nightfall full power is applied to the lamps.

How to build it. Mount photoresistor R5 on a weatherproof outlet

Continued

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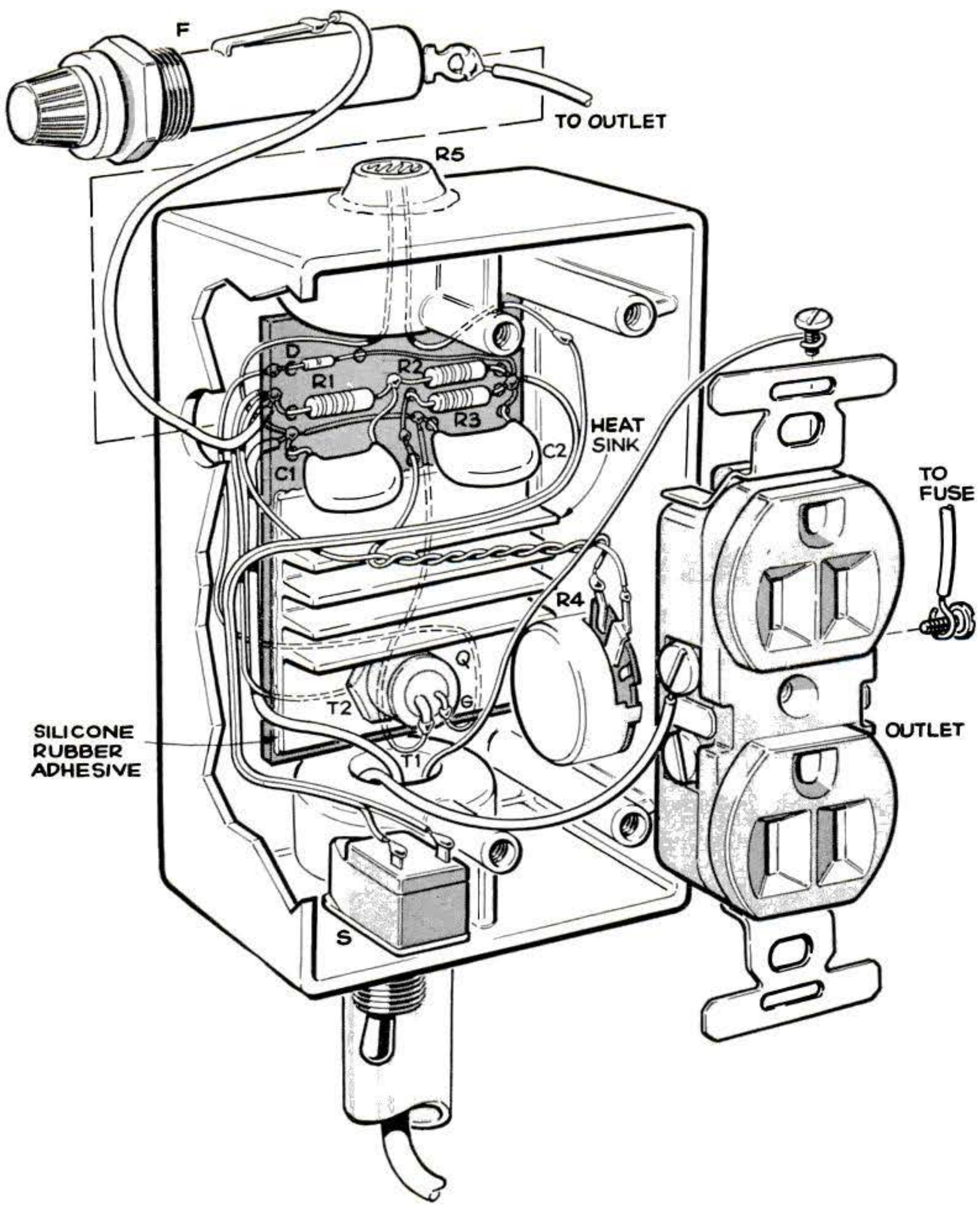

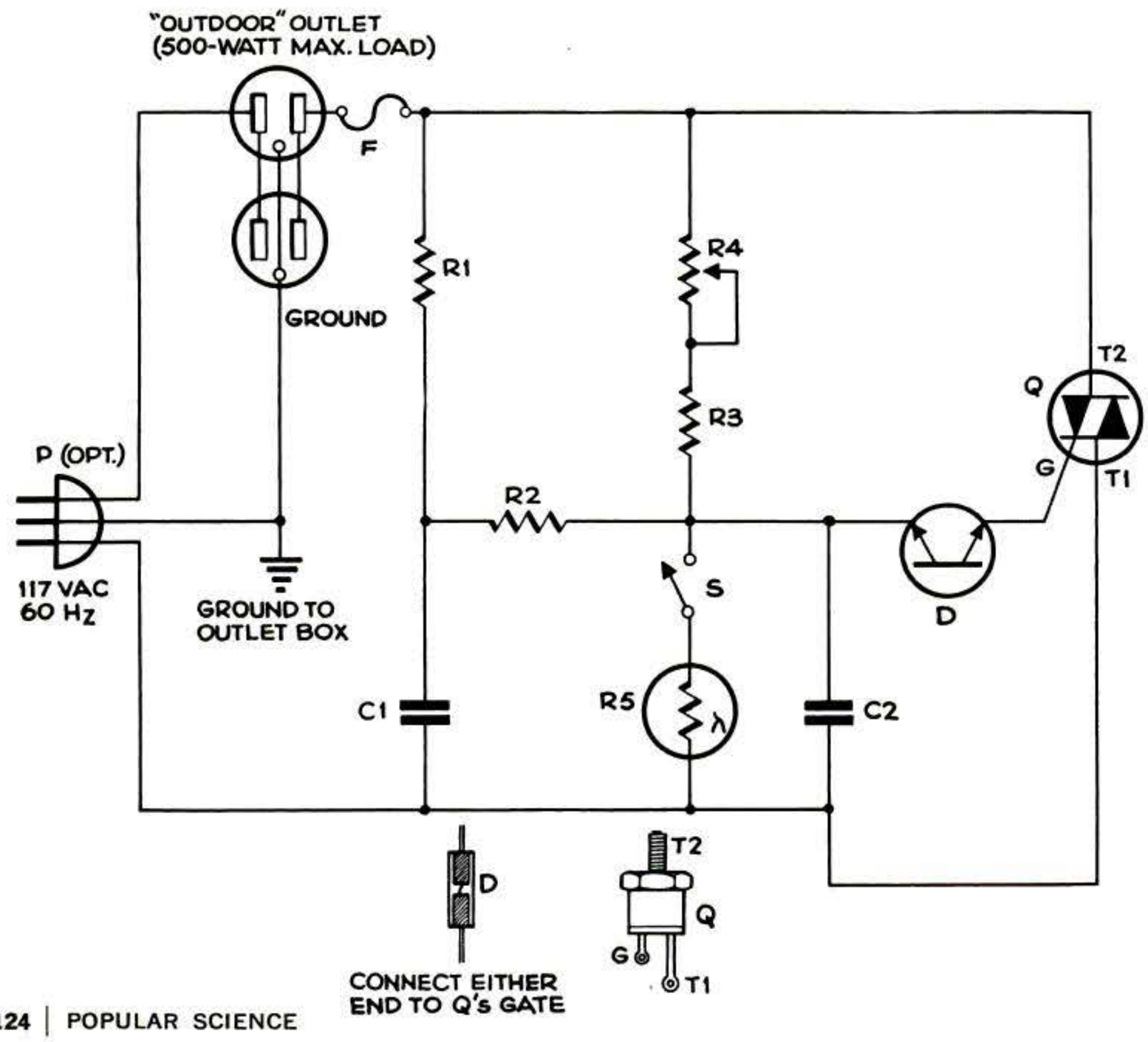

box. Drill holes for fuse F, potentiometer R4, and switch S. Use silicone rubber sealant to keep out moisture.

Cut the finned aluminum heat sink to size (about 1½" by 2" by 1/16"), cement it to the perfboard, and then cement the combination to the back of the outlet box. Insulate the heat sink from the walls of the box and other components. A bit of silicone grease between triac and heat sink increases thermal conductivity.

Install and adjust. My patio control is mounted on an 18" length of aluminum tubing set in concrete among the bushes. Three-conductor cable suitable for underground use runs from the control to the house.

The outlet box can be on the side of your house or garage if the building doesn't block the "eye" (photoresistor R5). Make sure R5 is not illuminated by the lamps it controls or any nearby lighting. Ground the box to the receptacle's ground terminal.

After assembling and mounting the circuit, test the unit. Use a grounded three-prong plug to temporarily power the patio control. Plug in a 100-watt lamp. With switch S open in the manual mode, the lamp should light; rotating the pot varies brightness.

Close S to put the unit on automatic and hold a piece of paper above the photoresistor. As you lower the paper toward the "eye," the lamp will light and grow brighter. (A slight flicker at low levels is normal.)

With S closed and a test lamp plugged in, rotate the pot until the lamp just goes out. Then as daylight falls off, the lamp will get brighter. A small knob on the shaft of R4 and markings on the outlet box simplify resetting.

Use caution. The 117 volts regulated by the patio control can be hazardous. Double-check your wiring, be sure the outlet box is grounded and follow local electrical codes. The patio control is designed to control electric lights only. Use with motors and other nonresistive or inductive loads may result in damaged motors and circuit failure. P

PARTS LIST

R1—68K, ½w carbon resistor
R2—47K, ½w carbon resistor
R3—4,700-ohm, ½w carbon resistor
R4—250K linear potentiometer (IRC type 11-130)
R5—Cadmium-sulphide photoresistor (GE-X6)
C1, C2—0.1 mfd, 200v Mylar capacitor (CDE 2P1)
Q—Triac (GE-X12*)
D—Diac (bilateral trigger diode, GE-X13*)
S—SPST toggle switch
F—5-amp fuse (type 3AG) and holder
P—Three-prong plug
Misc:—Double-receptacle outlet in weatherproof box with snap-covers and gaskets, finned aluminum heat sink approximately 1½" by 2" by 1/16", electrical cable, perfboard, silicone rubber sealant.

*Do not substitute. Available from Lafayette Radio Electronics and other electronic supply houses

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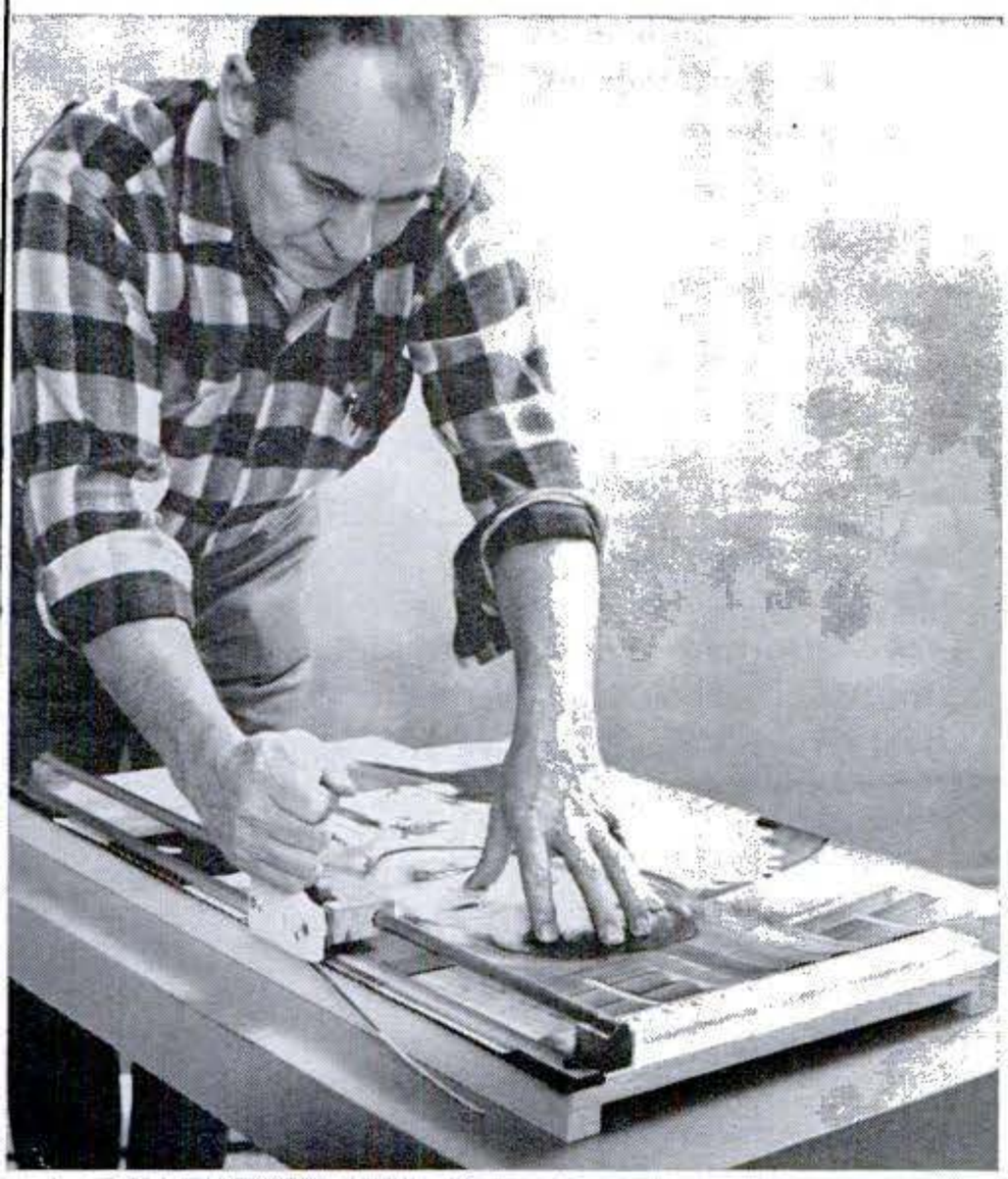
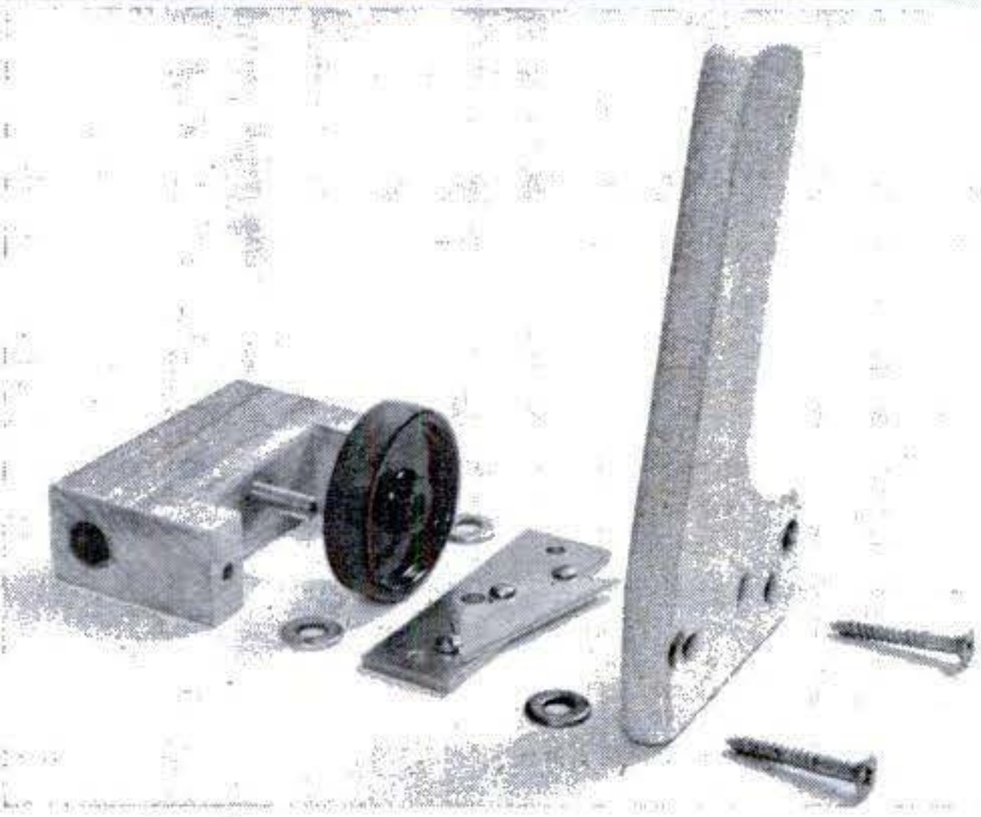
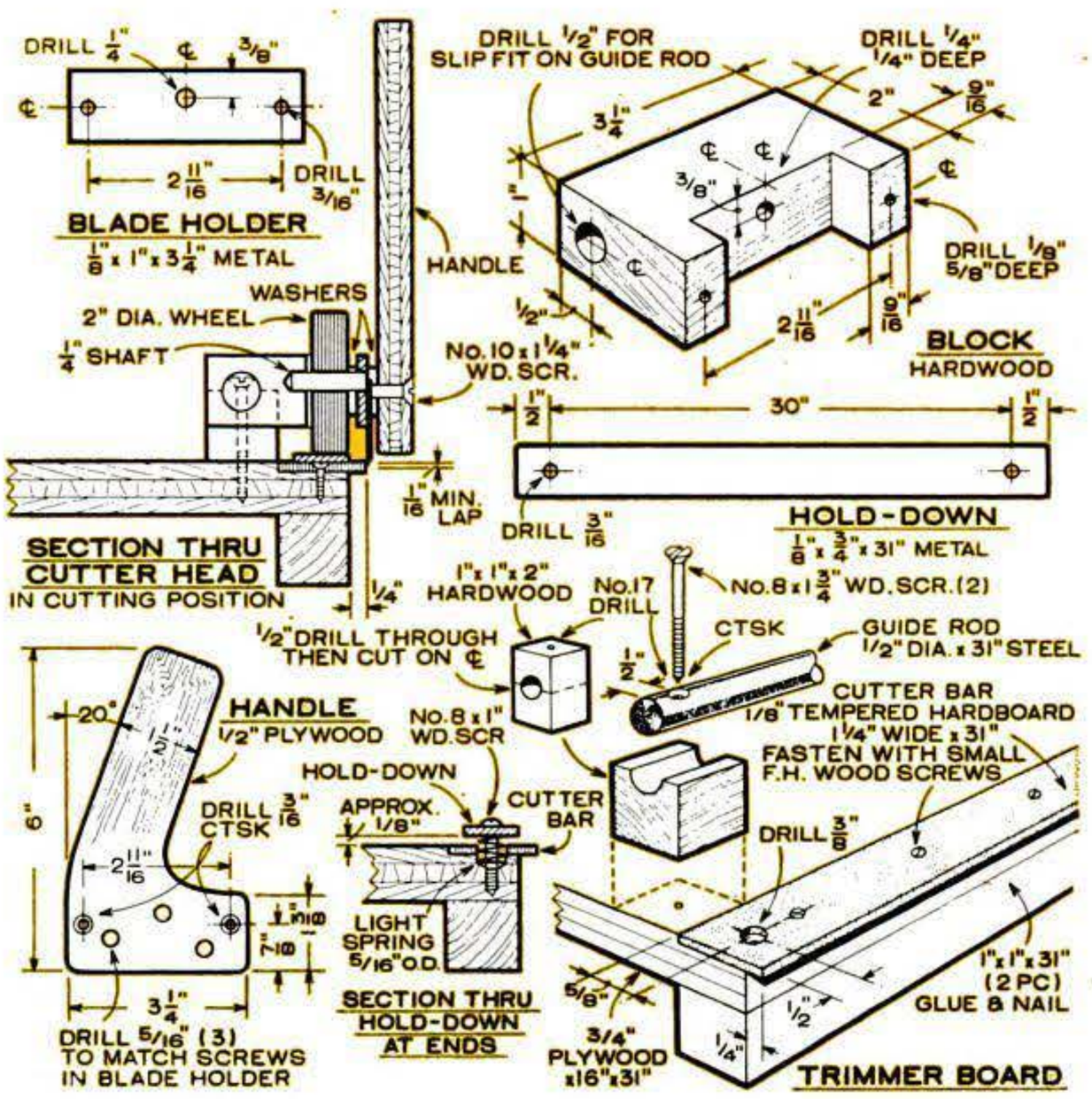
3 Bright Ideas for the Darkroom





Cutter head, ready to assemble: from left, block, 2" wheel, blade holder with screws clamping blade, handle.



Easy-to-make trimmer for poster-size prints

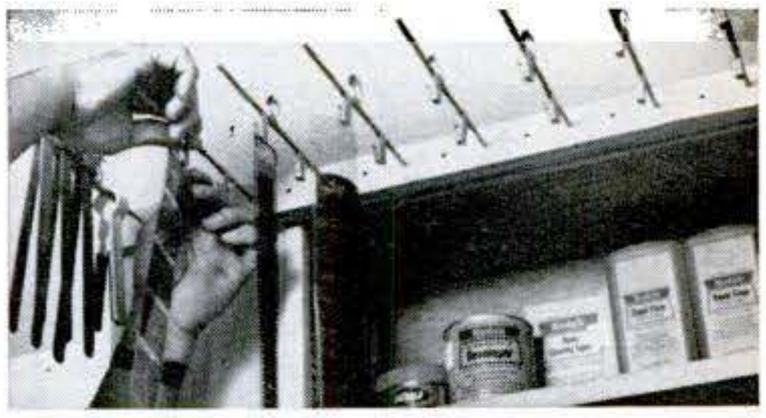
Make yourself a trimmer that can handle prints up to 24" long without a slip. A hold-down, supported at each end by springs, lifts for inserting an untrimmed print. A wheel from a teacart keeps pressure on the hold-down as you cut. The cutting head is guided on a steel rod, and a heavy-duty blade for a wallboard knife does the cutting. It's fastened to the holder with No. 6 binder-head screws. Three holes in the handle give access to these screws, permitting blade change without disassembly of the cutting head.

Grease the shaft when installing the wheel, use silicone wax on the guide bar, and touch up new cutter blades with a fine oilstone. A strip of masking tape on the underside of the hold-down will protect prints and keep them from slipping. When using the trimmer, bear down on the handle and pull the cutter head toward you with a fast continuous stroke.—*R. S. Hedin*

Processing large prints

Few darkrooms have trays big enough to handle poster prints. But plastic garbage-can liners let you process up to 16"-by-20" enlargements. Just label the bags for developer, stop bath, and fixer, then pour about a gallon of chemical into each bag. Move prints from bag to bag as if using trays, then wash in bathtub.

Even cheap enlargers will serve if you project negatives on the wall or floor. For an easel, use the cardboard in the paper package. Double-face tape secures the paper to the board at the corners and sides for sharp-looking borderless enlargements—at under $1 per print.—*Phil Cate*



Drying strip negatives

You can make this out-of-the-way rack fast if you have shelves over your darkroom sink. Drill holes 2" apart in a long, narrow board and mount it on a high shelf. Insert No. 6 Kodak clips in the holes to hold the film over the sink; remove them when not needed.—*Arthur L. Ramos*

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SHOP TALK

By ROBERT P. STEVENSON

Sears now offers service manuals for two home appliances

Those of you who are skilled enough to undertake repairs of a ho appliance will want to know, if you don't already, that the latest Se catalog lists service manuals, at $2 each, for two major home applian —the Kenmore automatic washer and automatic dryer. The man for the first has been available for several years; the second is a ne comer. The manuals are not designed to cover just a specific mod Instead, they aim to provide basic knowledge on the operation of appliance—always the first step toward repair of any machine—a give repair instructions in detail for most components used on models. That way, you can achieve a repair in most instances.

Note to other home-appliance manufacturers: Why not take a from Sears and make your service manuals available to everyo Sure, some attempted repairs will end up as basket cases. But ma of your customers are mechanically hep and could use the manua

Why can't you walk on a cement sidewalk?

That's a nice little riddle—and I hereby present it to you for next time you *must* make conversation. The answer is simple: Th is no such thing as a "cement" sidewalk. Speaking by the dictiona you can only refer to a *concrete* sidewalk.

A communication from the Portland Cement Association reminds of the frequent misuse of the two words. Properly speaking, ceme is an extremely fine grayish powder composed of calcium, silicon, ir and other minerals. Mix it with sand, stone, or gravel, plus water; the mixture harden—and then you have concrete. Not before.

A chart of most-often-useful drill sizes vs. screw sizes

Some time ago, after I had discussed what drill sizes a home wor shopper might own most profitably, a good reader, Rinaldo E. Wigg of Amesbury, Mass., sent along his own chart that substantially duces the number of drills you need. It is reproduced below. M Wiggin explained that he had evolved it on these concepts: that hor shops put most emphasis on wood working, that the smaller sizes a most often needed, that home shops seldom have electric drills larg than 3/8", and that the type of work does not require the optimu (such as always using the correct tap drill to produce exactly 70 to percent of full thread). I have asked other experienced shop users check out his chart—and they like it, too. So here it is—for you to c out, paste on a stiff backing, and hang over your bench. Smaller dri break most frequently. Use the chart to buy spares.

DRILL SIZES VS. SCREW SIZES

	WOOD				METAL		
Drill Size	Shank hole for screw:	Screw shank dia. (for ident.)	Pilot hole (hard wood)	Pilot hole (soft wood)	Body drill, mach. screw:*	Tap drills, mach. screw:	% of full threa
#2	#12	.2158				¼-28	60%
#5	#11	.2026				¼-20	65%
#9	#10	.1894			#10		
#15	#9	.1763					
#18	#8	.1631	#16		#8		
#24	#7	.1500				#10-24	70%
#26			#14		#6		
#28	#6	.1368				#8-36	60%
#30	#5	.1236	#12	#16	#5	#8-32	80%
#32				#14	#4		
#33	#4	.1105	#10			#6-40	70%
#37			#9	#12	#3	#6-32 #5-44	80% 75%
#39			#8			#5-40	75%
#43				#10	#2	#4-48 #4-40	70% 60%
#45			#7	#9		#4-36	75%
#48			#5	#8	#1	#3-48	75%
#51			#4	#7		#2-56	70-75
#55				#4, 5, & 6			

*O.D. of mach. screws = $\frac{13 \times \text{Size No.} + 60}{1000}$ (Ex. 13 × #10 + 60 = .190")
(Just remember the constants 13 and

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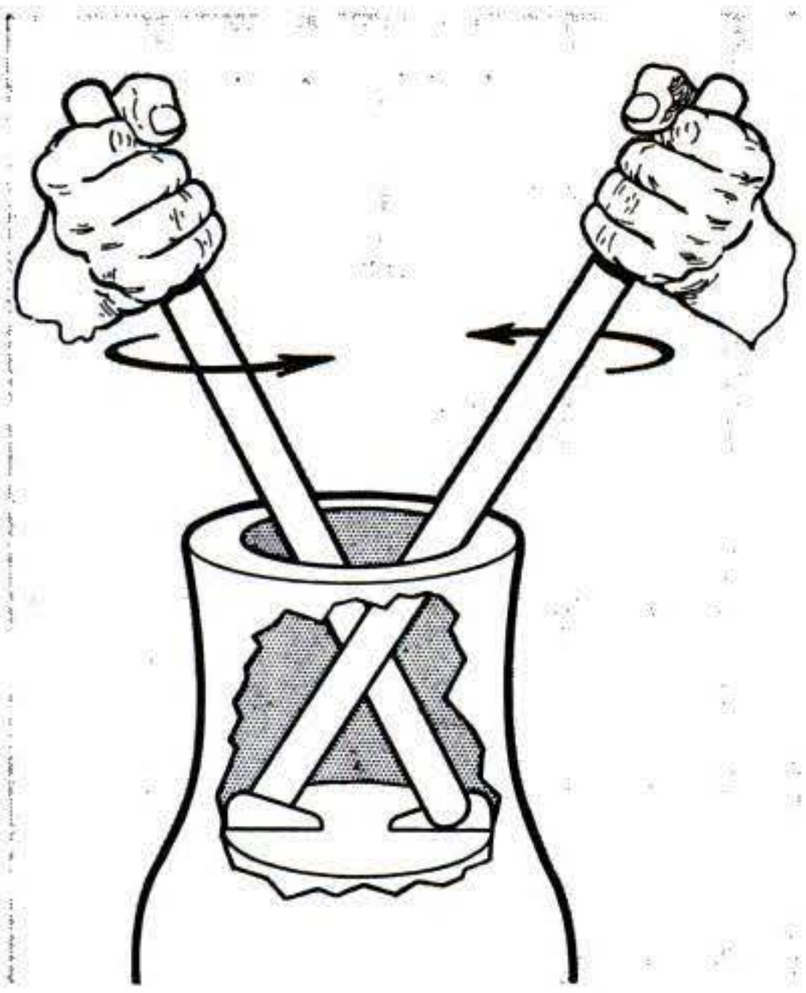
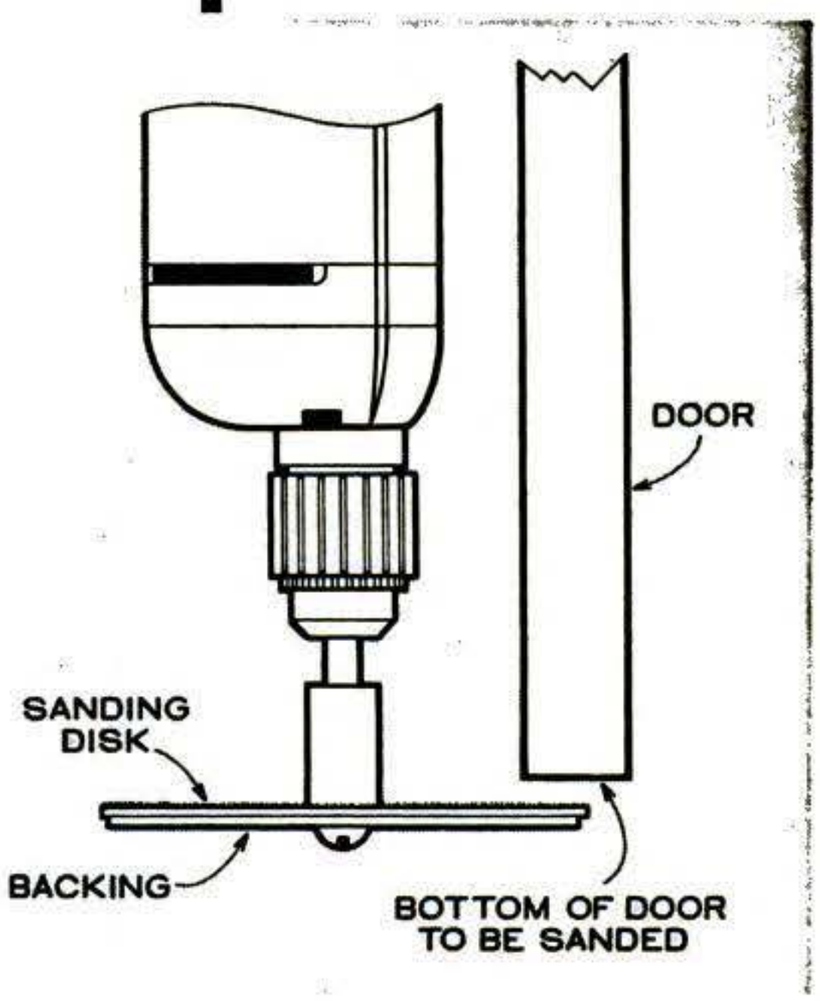
Three Good Home-Repair Tips



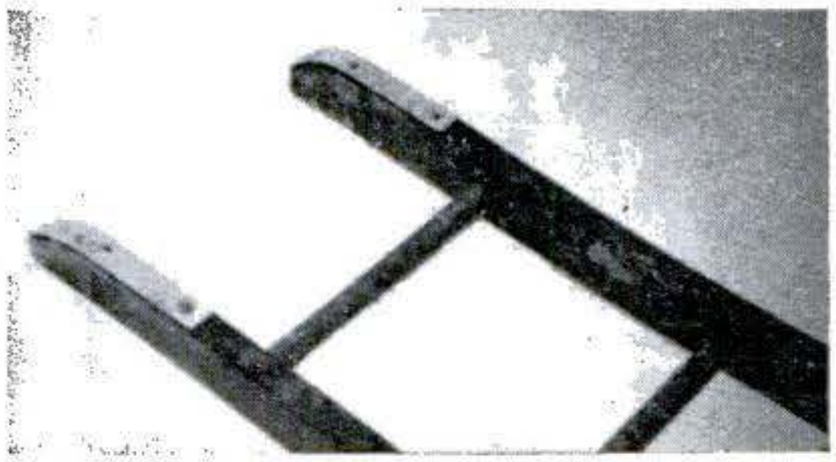
Free a jammed disposal with broomstick

The rotor plates of a garbage-disposal unit when jammed can often be freed with two 3′ lengths of broomstick. Insert them as shown in the sketch, so the ends rest next to the deflectors at opposite sides of the rotor plate. Then turn both upper ends in the same direction, so that each bears against the other where they cross. You'll get high turning force, yet the soft wood won't damage the cutters. A few turns in each direction usually frees the blockage.—*Roger L. Gaefcke*



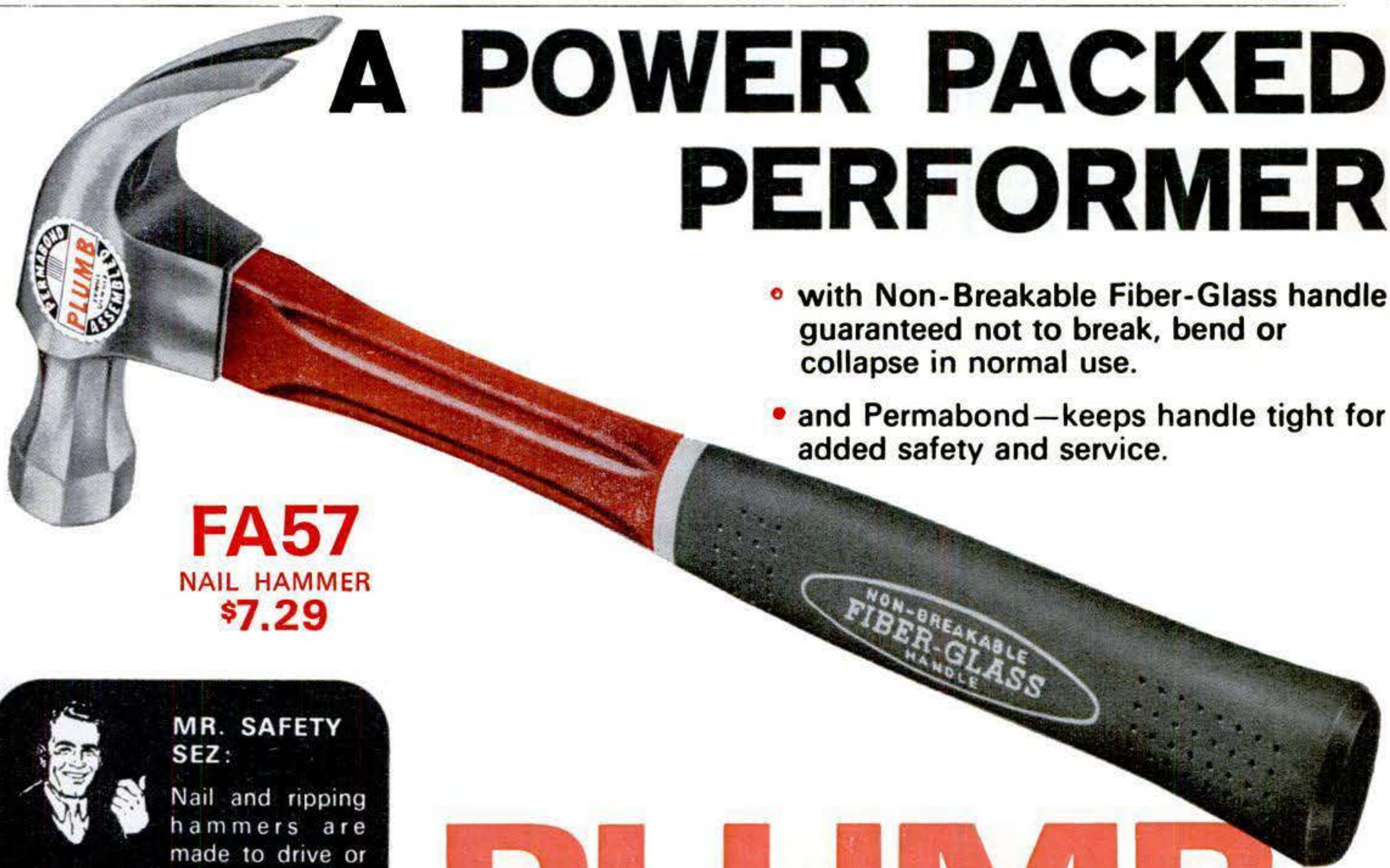
Pad Your Ladder

Tack strips of plastic—cut from jugs or bottles—on the upper ends of an extension ladder and it's much easier to slide it upward on a house. The plastic pads the wood, too, protecting the siding. —*Harold Neibert*



The easy way to trim a door

You can trim the bottom of a binding door without even removing the door from its hinges. Put a sanding disk on your electric drill, reversing it on the stud. Slide the disk under the door, and a little upward pressure will sand off the door in minutes. A metal sanding disk is ideal for the job.—*Joseph Giambalvo*



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CHILD'S WARDROBE: A "Housekeeper" You Can Build

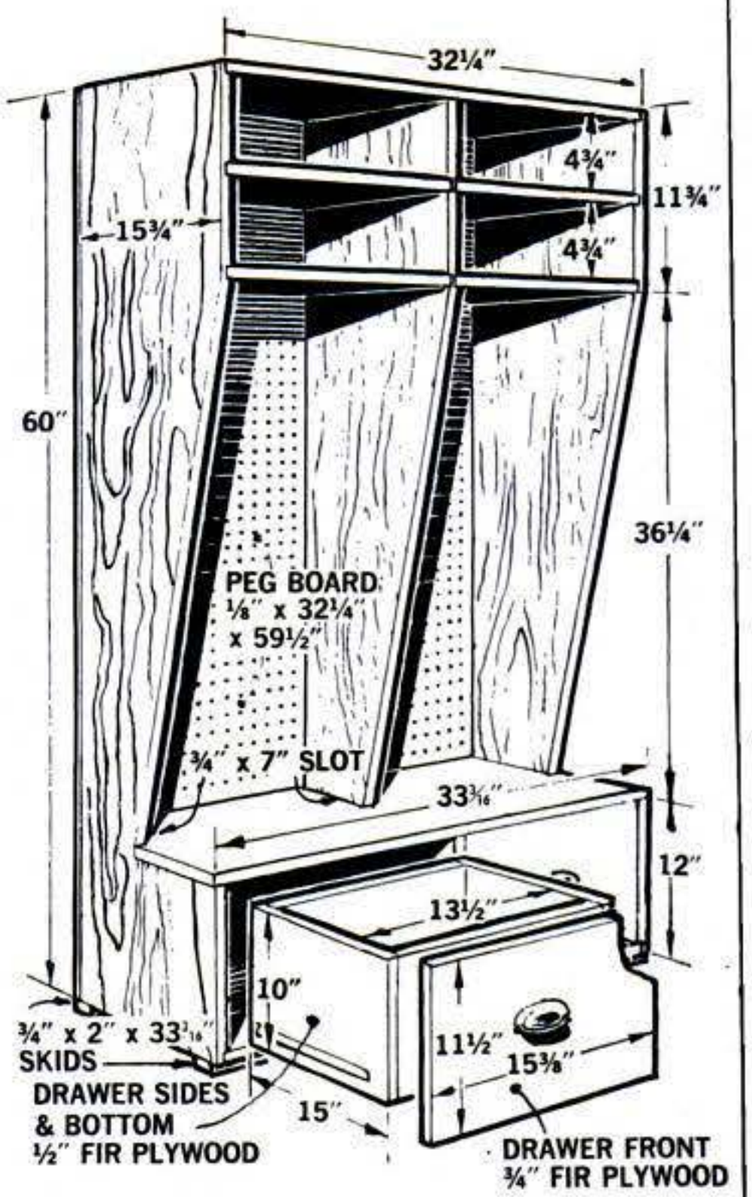
Just about the only way you can keep kids from messing up the house is to make it easier for them to be neat than sloppy. This wardrobe near your home's service entrance gives the kids a place to stow their books, baseball gloves, and jackets the minute they walk in the door. The slant-in design provides a place to sit while they remove muddy boots and shoes, and the drawers provide cover-up storage for the dirty footwear.

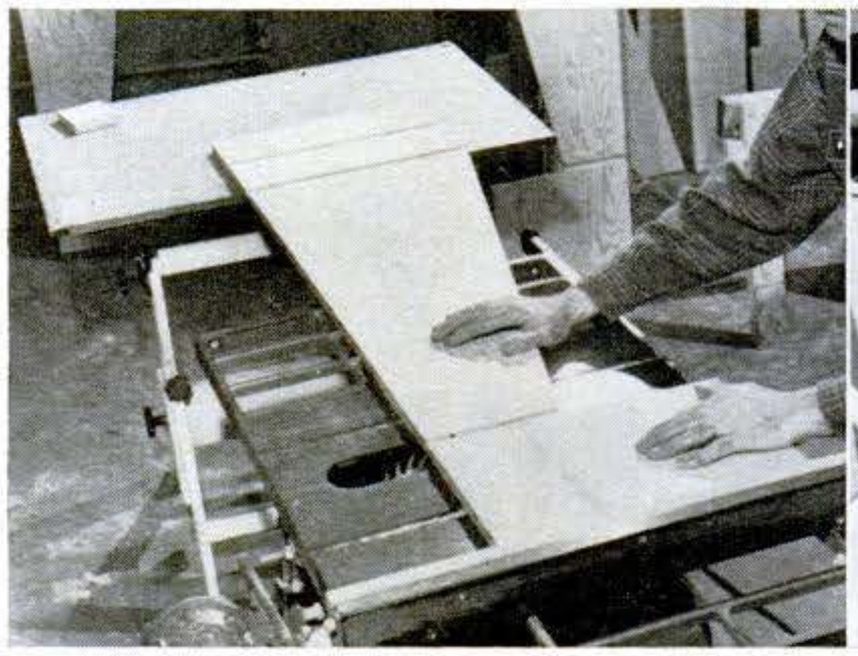
The wardrobe is easy to build from ¾" plywood. This double unit serves two children, but you can vary the number of stalls to suit your family needs.

The easiest way to make the angled cut in the vertical members is with a portable power saw. Clamp a guide board to the work to make the cuts smooth and straight. For a neat, strong unit, set the shelves into dadoes cut in the verticals.

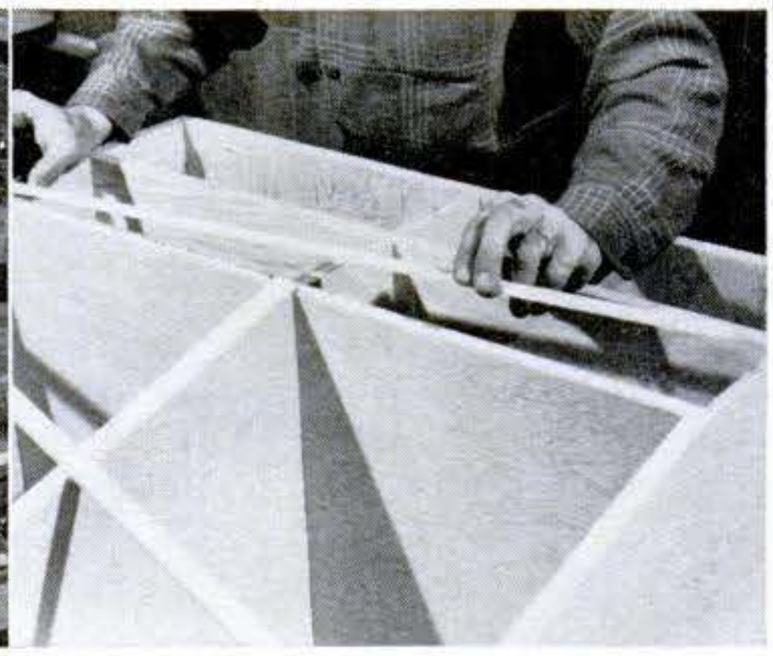
When you cover the edges of the plywood with pine facing strips, you'll also hide the dadoes. Two or three coats of enamel provide an easy-to-clean protective finish and add color.—*Ro Capotosto*

Always ready at the door, the wardrobe handles the kids' belongings as soon as they step inside, before they can clutter up the house.



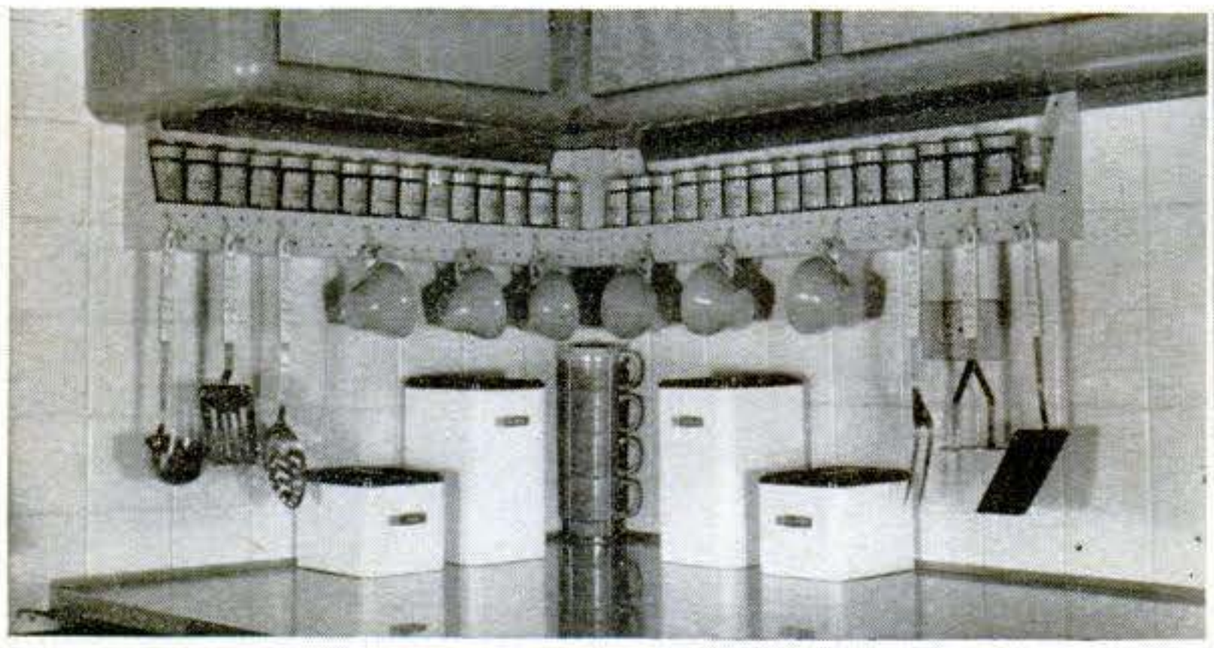


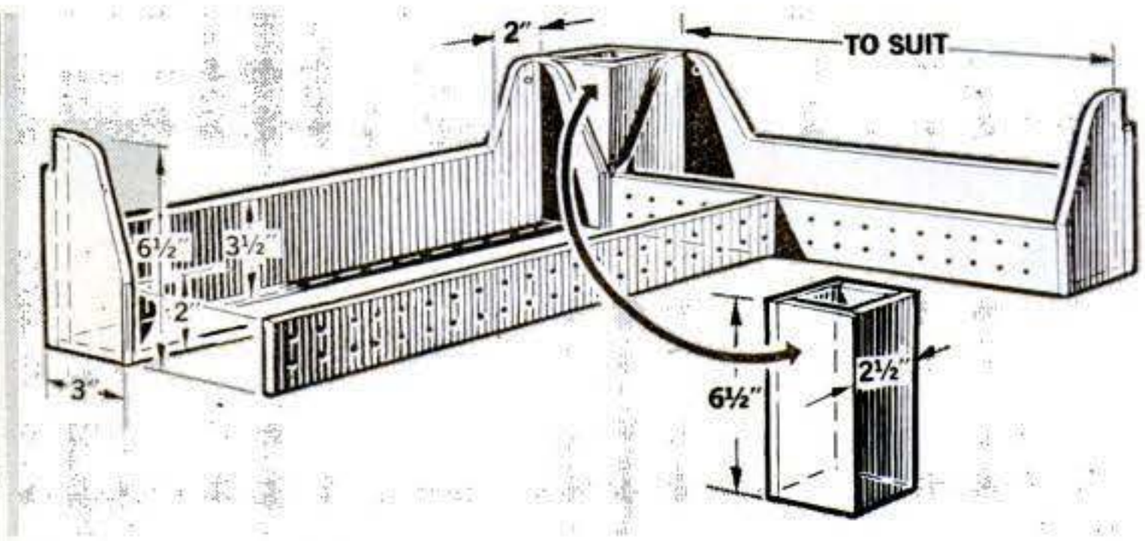
Blind dadoes cut into the verticals contain the shelves and seat solidly, so you can use glue and nails for quick, easy assembly.



Strips of clear pine face the exposed edges of the plywood. They cover dadoes and take finish better than raw plywood edges.

Space-Saving SPICE RACK





Rack fits neatly into the wasted space beneath your kitchen cabinets, stores a full selection of spices in easy reach.

After an unsuccessful shopping trip in search of a spice rack, my wife decided we'd have to design and build our own. The Early American style available just didn't fit our modern kitchen—in terms of space or style. The rack I came up with fits snugly in wasted space under our cabinets. Its perforated-hardboard front provides hanging storage for pots and kitchen utensils.

Buy a matched set of spices first, then size the rack to fit the set. Be sure to allow space for the hooks to engage the rack in front of the bottles. The unit shown is designed to fit a corner, but is easily adapted to one-wall service.

The rack goes together quickly with brads and glue. Drill pilot holes through the hardboard. If you don't, the brads will bend and the board will chip.—*Patrick Abbeduto*

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New Help for Cars in Trouble

[Continued from page 34]

M. Chiaramonte says: "The results of the two-year test in Ohio will give a pretty clear picture of the effectiveness of a nationwide system of this nature." The GM Research Laboratories are lending their computer to ally and evaluate the results of the Ohio test.

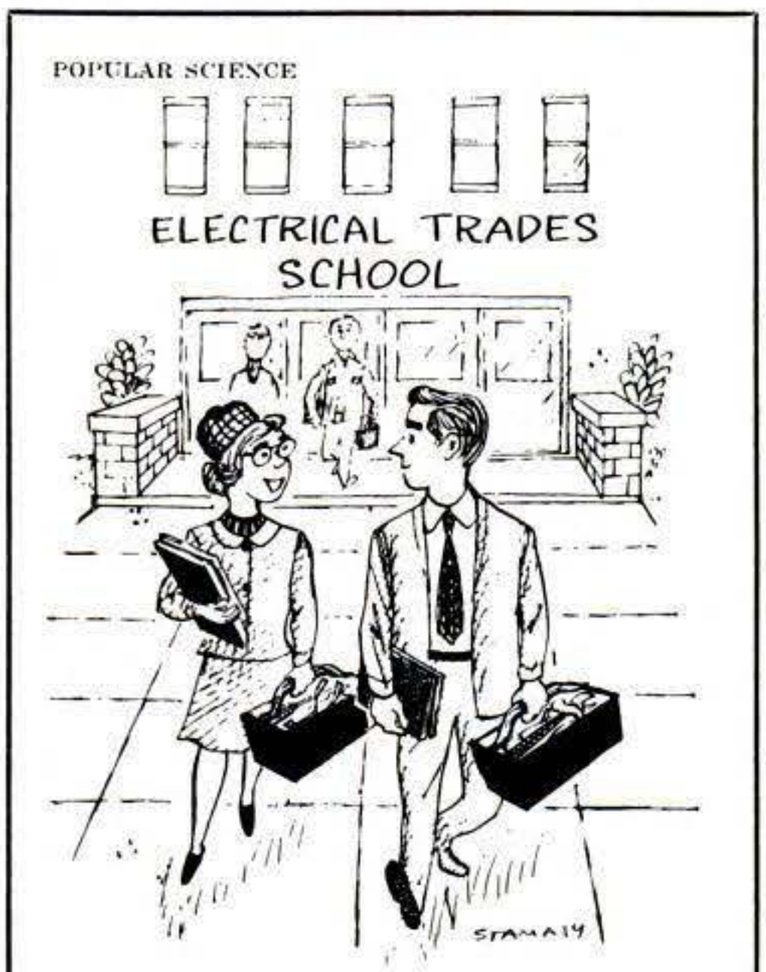
Interestingly, the E.I.A. reports that 500 different police and fire departments across the U.S. already monitor Channel 9. In many locations, local service stations have signs on highways telling CB-equipped motorists that they can call for tow-truck assistance.

Although the automotive safety applications of CB radio are obvious, the Channel 9 rule can aid other emergency situations, too.

Hunters, hikers, and campers can tote lightweight portable CB walkie-talkies with them—just in case. And, CB can supplement marine radiotelephone on boats.

Ready when you are, CB. CB transceivers (combination transmitter/receiver) are as easy to use as a telephone—flip the selector knob to the desired channel, and push a button on the microphone to talk. Release the button to listen.

Any U.S. citizen over 18 is eligible for a CB license. There are no examinations or special training. Fill out a form, and send it with an $8 fee to the FCC. Forms are available at CB equipment dealers or your local FCC field office.



"My time-saving appliances allow me enough time to learn to repair them."

Lower prices? Battery-powered walkie-talkies, dash-mounted CB rigs for your car, and fixed-mount "base stations" for home setup come in a wide range of prices, typically from about $80 on up, depending on features. Installation and antenna, if required, are additional. A good-quality five-watt (the maximum legal power) unit for your car, complete with antenna costs between $100 and $150—about as much as a good auto radio. Depending on terrain, this kind of combination will provide reliable communication over a 5-to-30-mile range.

The new-car options may bring a reduction in prevailing prices. You would buy only a set for the car, not necessarily one for your home.

The unit would have multi-channel capability—that is, the ability to operate on at least two different CB channels. This is a good idea even if you plan to use your CB rig only for emergency transmissions. The reason is that once you have established communication with a REACT team member, or other monitor, you should switch to another frequency to leave Channel 9 clear for other emergency transmissions. PS

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Minto's Steamless "Steam" Car

[Continued from page 53]

moving within the boiler coils so no hot spots or gas pockets form. Transformation from liquid to gas occurs as the fluorocarbon is valved automatically into the vaporization chamber, where recovered heat from the burner exhaust heats it further. This, among other things, is an economy measure. The maximum temperature of the exhaust from the car's burner is 450 degrees—this only on hard acceleration. Automatic sensing of boiler pressure controls fuel flow to the burner at a ratio of about 10 or 12:1.

Fluorocarbon gas at 350–375 degrees F under pressure up to 250 psi is throttled to the engine in response to the driver's accelerator pedal. The engine turns and the car moves. For additional torque at highway speeds, a kick-down switch pops open a solenoid valve to introduce gas later in the rotation cycle. In steam-engine parlance, this changes the cutoff point. In automobile terms, you can really peel rubber.

After leaving the engine, the R-113 gas passes rearward and upward to the condenser plastered against the roof top. Doubting engineers claim the condenser size will be overwhelming. Minto, using internally and externally finned Alcoa aluminum extruded tubing, says it's no problem. The semi-condensed gas leaves the rooftop unit in a "fog" state, partially liquid, and enters the secondary condenser, which provides final cooling and acts as a storage tank. This secondary condenser is not really needed except under full load conditions.

A simple condensate pump, powered by a small amount of gas acting against a piston with differential diameters, serves to force the liquid back into the boiler to repeat the cycle.

Same fuel consumption. All of this is accomplished with a fuel consumption about the same as the internal combustion engine in the Datsun. Kerosene is denser than gasoline, and has more BTUs per gallon. With minor changes to the burner, very cheap grades of fuel oil could be burned.

The car now under construction will be about 10 percent heavier than the original Datsun because it uses hand-built parts plus components adapted from other applications. By fabricating parts especially for the car, eliminating the present transmission and drive line, and taking full advantage of the engine placement possibilities, the ultimate car weight will be the same or less than that of the present internal-combustion model.

Two other happy results are expected. One is an on-the-market car price 10 to 20 percent lower than with the present engine. The other bonus is better handling because of a lower center of gravity. This stems from the location of the boiler and its contained fluid under the floor. Moreover, hard braking at speeds over 45 mph builds up a reverse pumping action that slows down the vehicle promptly.

What about safety? Boiler explosions have haunted steam engines from the beginning. Wallace Minto has several answers to this objection. He points out that every car with air conditioning has Freon working at several hundred psi and temperatures of 200–250 degrees F. This seems to pose no special hazard, even in an accident. Of course, his engine would have 80 to 85 pounds of R-113 in the system. On the other hand, the boiler is of the liquid-tube type, and a failure is likely to produce a small leak within the double-walled protective housing. This is equivalent to a small valve leak in a tire as compared to a blowout—quite unlike the bursting of a fire-tube boiler shell. Accidents in the test program have shown that hot fluorocarbon blasting into the air travels about an inch and almost instantly cools to outside boiling point, 117 degrees F—hardly a scalding temperature. And, of course, the kerosene fuel is less of a fire hazard.

Is Minto's engine just another dream, or is it really headed for production? As we went to press, Minto announced that he had signed a multi-million-dollar contract with Nissan of Tokyo, calling for mass production of the engine and its use in Datsun automobiles made in Japan. The inventor estimated that more than 100 Minto-engine-equipped Datsuns would be manufactured in 1972, after he has delivered first a demonstrator model and then a production prototype. After that, he believes, production will be greatly increased.

Minto also hopes to provide a higher-powered version of his engine to a Japanese manufacturer of boats, tractors, and construction equipment.

Nissan will have exclusive rights to manufacture the auto engine in Asia, but the way will be left open for Minto to make similar arrangements with European or American car makers. So far, at least, no American firm has shown signs of interest.

Living in a tightly packed country where pollution is an even more acute problem than here, the Japanese seem to be a bit more open to new concepts. Ironically, the world's first production car to meet proposed American federal pollution standards may be made in Japan. PS

Bike with a Car Battery

[Continued from page 79]

tensioning spring over the head of ar of five machine screws set in tl right-hand side plate. The spring upper end fits onto a ¼" thread rod, stiffened by nuts on either sic of the spring arm. You can swing tl motor up off the tire by attaching tl lower end of the spring to a ¼" bo through the side of the bike's fran just forward of the battery.

The pulley is fixed on the mot shaft with a pin supplied with tl motor. I contoured the pulley match tire shape and wrapped plast tape around the contact area of tl pulley to increase friction.

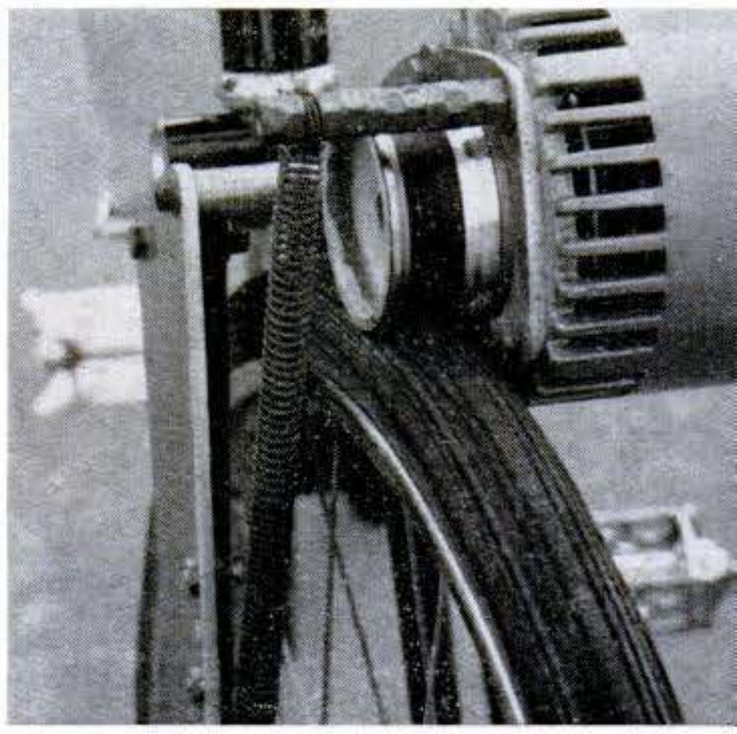
Battery mounting. The battery res on two 5" lengths of ¾"-by-¾" ang iron ⅛" thick. They're bolted to tl frame through a 1"-wide tab at ce ter of each bracket. The tabs a made by hacksawing two cuts a inch apart, then bending the met between the cuts until tab ang matches frame angle.

Two 6-32 threaded rods, laid b tween the battery's ends and i brackets, support side straps of 1/16 by-⅜" aluminum. Four ¼"-diamete spacers of aluminum tubing on tl ends of the rods prevent sideway ba tery movement.

Drive motor. The Minn-Kota m tor has three speeds, selected b switching taps on its series field win ings with a rotary wafer switch. Us ing the pulley described on a 26 wheel, level-ground speeds are fou eight, and 13 mph. Speed falls off o modest hills, and you have to peda a little on steep ones.

I found that current drain average about 15 amps. So a 60 amp-hour, 12 volt battery provides four hours about 40 miles—of riding. To reduc rolling resistance, I keep my tires in flated to between 60 and 70 pounds

One reminder: Police may chal lenge you when you take to the roa on your motorized bike! PS



Friction drive uses a screen-door sprin to hold the motor pulley against a tir

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Why Apollo 13 Failed

[Continued from page 66]

l. The investigators decided to e further. A team was set up to ılate the unorthodox detanking edure and see what had happened. y installed the fans and heaters tank, turned them on, and let ı boil out the oxygen—the way it done on the launch pad.

hen they opened the tank. And e was the most startling discovery ıe entire investigation. *The ther- tatic switches that were supposed eep the heater from overheating welded shut.*

ooking back through the record ed up some interesting facts. The ecraft had a 28-volt electrical em. So the heaters and switches been designed to operate on 28 s. Originally, the ground-support pment at the Cape had supplied volts to the heaters, too. But to d up pressurization on the pad, ground-support voltage supply later been upped to 65 volts. The ers could take it. The thermo- ic switches couldn't.

eech engineers didn't notice the repancy. Neither did North erican Rockwell, which reviewed design. Neither did NASA engi- s, who checked it all out again. So switches weren't changed.

had no affect on the earlier Apol- lights. So long as the tank was rly full—as it always had been the pad when the ground-support volt heater current was used—the ercold oxygen itself kept the heater n getting too hot. In space, had switches been called upon to oper- they would have worked perfectly the spacecraft's 28-volt supply. because of the tank-emptying blem, the 65 volts had been ap- d to the heater for fully eight rs—until the tank was empty.

The tests at Houston showed what happened. Thermocouples were alled on the heater tube and the ver turned on. The temperature , to 600°F, 700°F, 800°F—1,000°F spots. A team at NASA's Ames earch Center, Moffett Field, Calif, Teflon-insulated wire and baked nder similar conditions. The in- tion cracked, crumbled, fell into mable chunks.

low the plot was clear. Before llo 13 ever left the ground, the sual detanking procedure had rred and cracked the insulation on fan wires in oxygen tank No. 2. ing somewhere along its length inevitable.

Now it was time to put the whole g together. A tank the size and pe of oxygen tank No. 2 was built, d out, filled with supercritical

[Continued]

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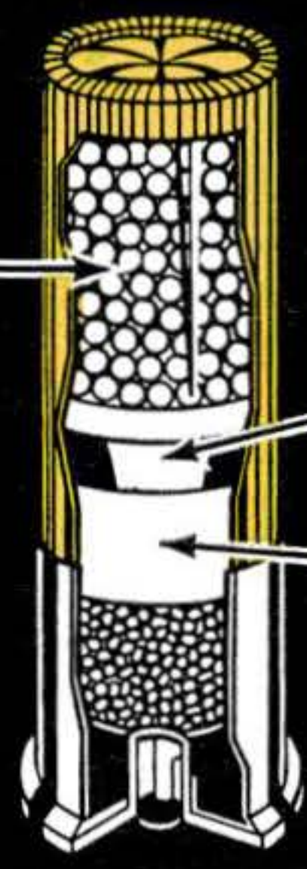

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oxygen, and installed in a vacuum chamber in the Thermo Chemical test facility in Building 351 at the Manned Spacecraft Center just south of Houston. On June 4, the testers ignited the insulation of the fan wiring to simulate the way they now knew it had failed in the Apollo 13 tank. The insulation burst into flames. The pressure shot up—just as it had in the tank aboard Apollo 13. Flame traveled along the wire and into the ⅝-inch steel conduit through which the wires entered. The conduit parted suddenly, and a gusher of high-pressure oxygen exploded out of the tank.

There was a small hitch. The burning was too fast—almost twice the rate it had been in space. But engineers knew that burning goes more slowly in space, without the normal effects of gravity to help spread it around. So they decided to test the burning rate again, this time under weightless conditions. NASA's Lewis Research Center in Cleveland has a tricky way of creating weightlessness right here on earth. It's a hole in the ground, 500 feet deep, lined with instruments. An experimental package can be dropped down the hole, giving about five seconds of free fall. A bed of plastic pellets at the bottom absorbs the impact.

When a specially designed burning experiment package was dropped into the hole at Lewis, the burning rate was precisely the same as it had been on Apollo 13.

Now the exploding tank was completely explained. Only one troublesome detail remained. A team of engineers working on the panel that blew off made a disturbing set of calculations. They figured that oxygen escaping into the interior of the service module would pressurize it, eventually blowing the panel off when the pressure was high enough. Blowing the panel, their figures showed, would take a uniform pressure of about 20 pounds per square inch. But if the pressure reached only 10 pounds per square inch, it would separate the command module and the service module. That didn't happen.

Why not? Another team, this one at Langley Research Center in Virginia, set out to see. In a 60-foot spherical vacuum chamber, they built a half-scale model of service module Bay 4, simulating all internal volumes, shapes, and vents. Where the oxygen tank had been, they installed a tank with a valve that could simulate th tank failure and let the gas escape a any desired rate.

When the oxygen rushed out at moderate clip, they found, it diffuse through the entire spaceship. Whe the pressure reached 10 pounds pe square inch, the command modul would have separated, just as ca culated.

But when the oxygen gushed out i a fraction of a second—as had hap pened on Apollo 13—it was a differen story. The pressure within the tan compartment rose to more than 4 pounds before gas could seep aroun and pressurize the front of the modul to the 10 pounds necessary to separat the command module.

Case closed. The half-scale trial wa spectacular, happening so fast it coul be seen clearly only in ultraslow motion movies. Within millisecond after the experiment began, the pane bulged in the middle. A crack ap peared along one side, then a split A slab went flying outward, then th whole panel exploded into space. An with the clanging of the explodin panel against the steel walls of th vacuum chamber, the case was closed

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gredients: the dropping of the shelf that displaced the fill tube so the oxygen couldn't be emptied during a practice countdown; the decision to use the heater; the 28-volt switch that should have been changed but wasn't; the overheated insulation, the cracks, and a spark; the burning insulation; the explosion.

The accident, said the board in its final report, "resulted from an unusual combination of mistakes, coupled with a somewhat deficient and unforgiving design." The report criticized both the companies involved and NASA planners for not spotting the potentially hazardous combination in the tank. They should have recognized it, the board said, during the investigation following the fire that killed Gus Grissom, Roger Chaffee, and Edward White in early 1967. At that time, the craft was largely redesigned—to eliminate fire hazards.

What will be done? The committee recommended a number of changes. As a result, the new tanks will have heater wiring enclosed in steel tubing and totally isolated from oxygen. The fans will be removed entirely and a third oxygen tank added. Now there will be so much oxygen that it doesn't matter if the gauges read somewhat inaccurately; this eliminates the need for stirring.

Checking since the accident has uncovered one further booby trap: a valve that contains exactly the same ingredients that doomed Apollo 13—Teflon insulation and supercritical oxygen. It is being redesigned. And a complete review of the entire spacecraft design is in progress; the report is due in late September.

Ironically, the switch that caused all the trouble was removed from a spacecraft then being built—about a year ago. Had there been no accident, only Apollo 14 would have flown with the switch in place; later models have had it removed for other reasons. It was decided that the fateful thermostat was not needed. Under normal conditions, the supercold oxygen itself keeps the heaters from getting too hot. The thermostats would come into play only as a tank was nearly empty and warming up.

But that doesn't happen. Even with just two oxygen tanks, the Apollo flights carry a far larger supply of oxygen than they can use. So they always come home with the tanks still 30 to 40 percent full. The only time in the entire Apollo program the switches were ever called on to work was during the practice countdown of Apollo 13. But for that job, they didn't match the voltage available, and they failed.

Can it happen again? Could Apollo 14 or 15 or 16 fly with yet another bomb of some kind lurking inside? "The management system that exists now did not exist in the early days of Apollo when most of these systems were designed," says Kilgore. "Just as an example, today that blind assembly would never get through. And there is now a simple sentence in the checklist: 'Check all interfaces.' That one sentence would have caught that switch." And chances are that the current review will pinpoint any other problems.

In the introduction to its final report, the panel wrote these words: "The Apollo 13 accident, which aborted man's third mission to explore the surface of the moon, is a harsh reminder of the immense difficulty of this undertaking."

It's a reminder, too, that no matter how easy the earlier missions made it look, space flight will never be 100 percent safe. PS

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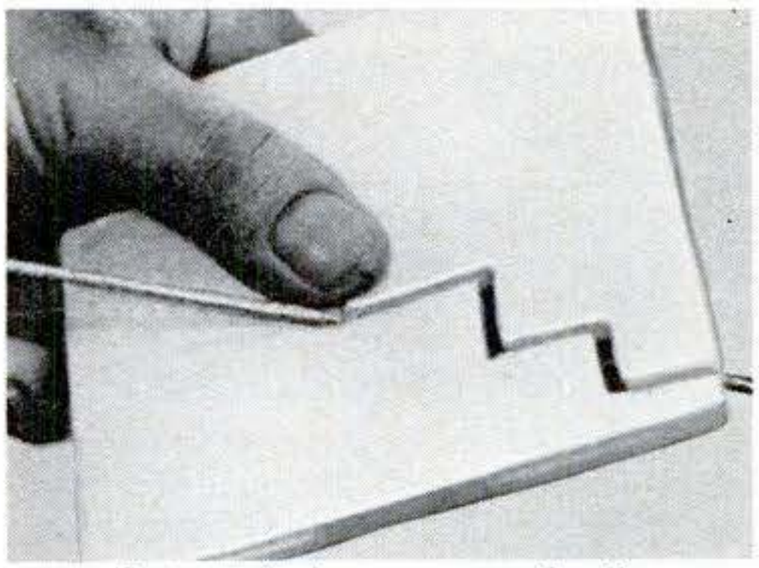
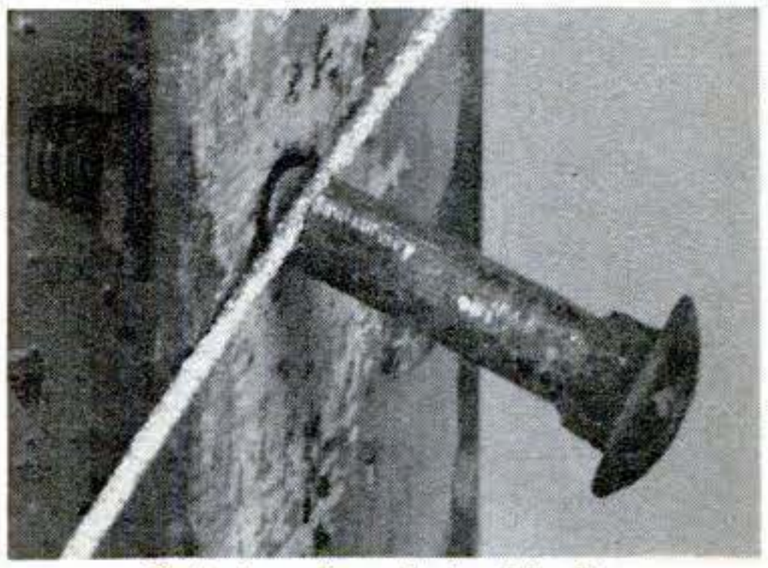
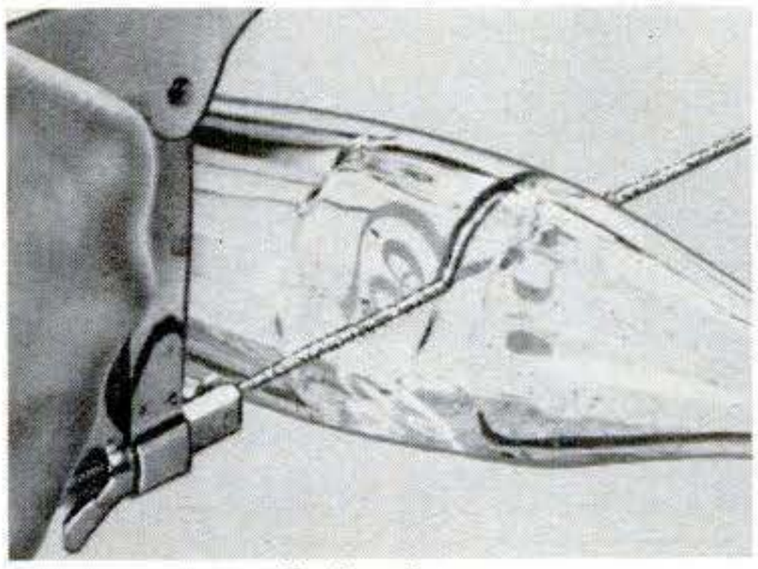
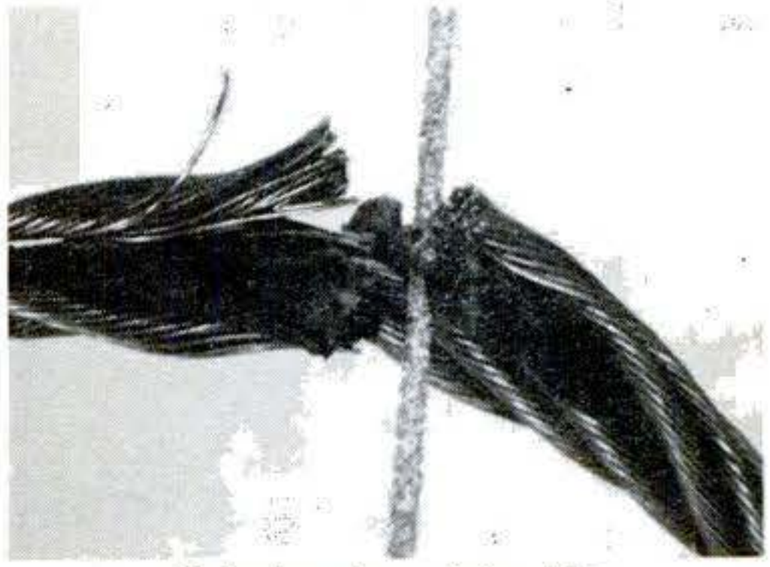

Cuts and shapes ceramic tile.


Cuts hardened steel bolts.


Cuts glass.


Cuts tough metal cable.

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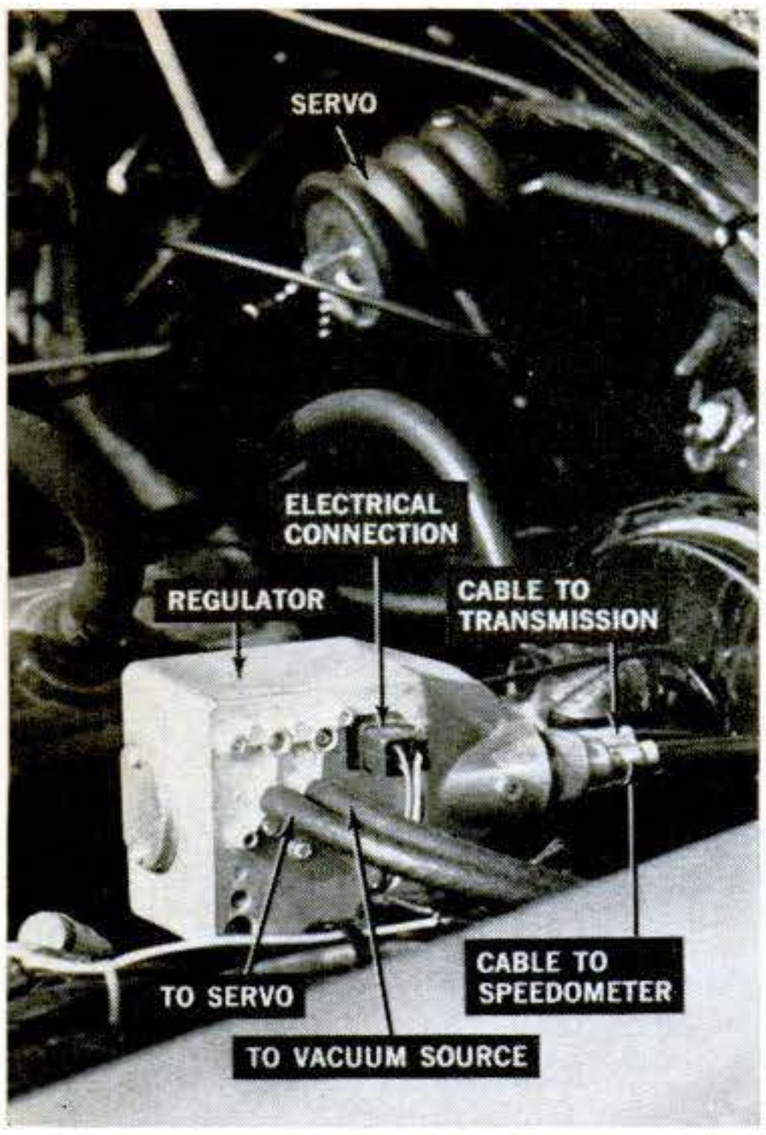

Two connections form the heart of the Speedostat system: an electrical hookup to the regulator, and a vacuum line to the servo unit, which also connects to the throttle linkage at the carburetor. The cable running from the transmission is replaced by one running to the speedostat regulator. You mount the regulator on the wheel wall or some other metal surface, the servo on the firewall. You will find all other connections detailed in the booklet.

PERSONAL-USE REPORT

A Speed-Control Kit for Your Car

Now it's possible for anyone to add a speed control to his car or recreational vehicle. A new kit, engineered to fit any domestic make with only a variation in speedometer cables, has been developed by the Perfect Circle Division of Dana Corp. It's available at Montgomery Ward retail stores, and automobile accessory stores.

With the help of a friend, I installed the kit on my 1970 Buick LeSabre. Using the installation booklet, which breaks the job down into 25 easy-to-understand steps, it took us only three hours.

The Speedostat has an engagement switch and a master On-Off switch on the dash. The system will not activate below 40 mph, but above that you operate it by turning on the master switch and pushing the engagement switch. Remove your foot from the accelerator and the car will continue at that predetermined speed —on a level road, or up and down a hill. To increase speed, you step on the accelerator. Take your foot off the gas, and the car will drop back to the preset speed. Touching the brake pedal disengages the system.

In addition to master switch and brake disengagement, there's another safeguard. A drop in speed of seven to 15 mph will disengage the system automatically--important if the brake disengagement fails.

The regulator is driven by a flexible drive cable from the transmission, the speedometer by one from the regulator. Vacuum from the intake manifold to the regulator is controlled electrically by the engagement switch. A governor in the regulator controls the vacuum servo, which in turn regulates the throttle.

Designed primarily for cars with automatic transmissions, the Speedostat can also be used on manuals. But it will cause the motor to race if the clutch is disengaged while the unit is on. With a larger servo, it will also fit on light trucks and recreational vehicles.

At Montgomery Ward stores the unit sells for $69.95, and if you wish they'll install it.—*Jerry Copeland*

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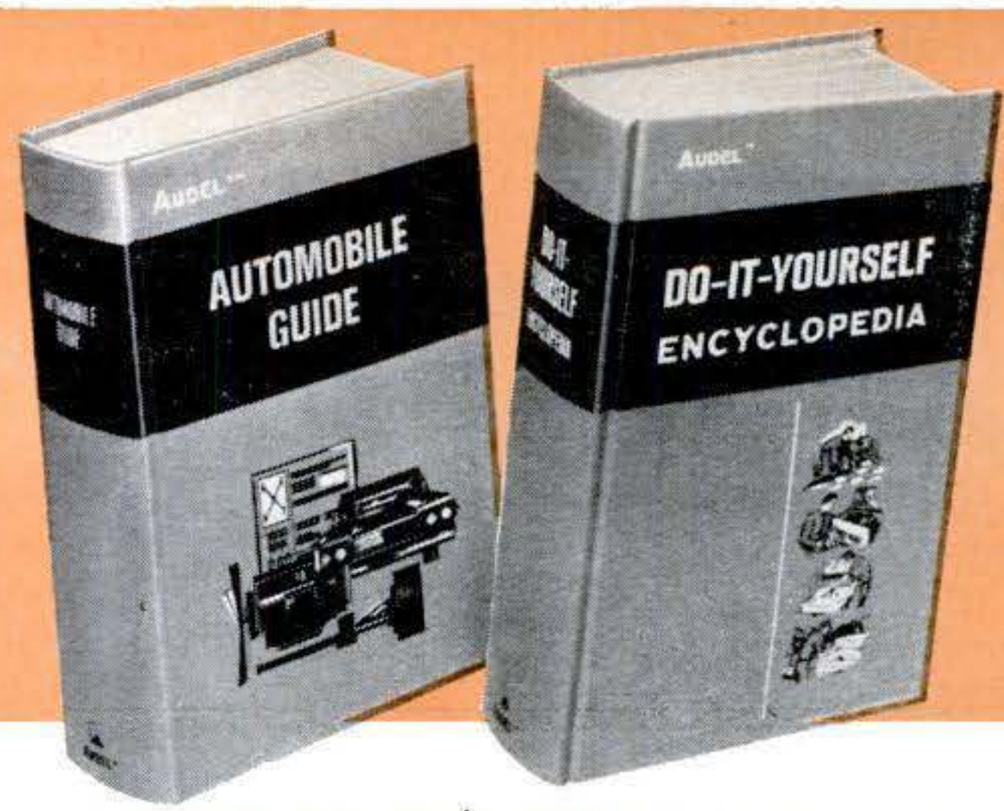

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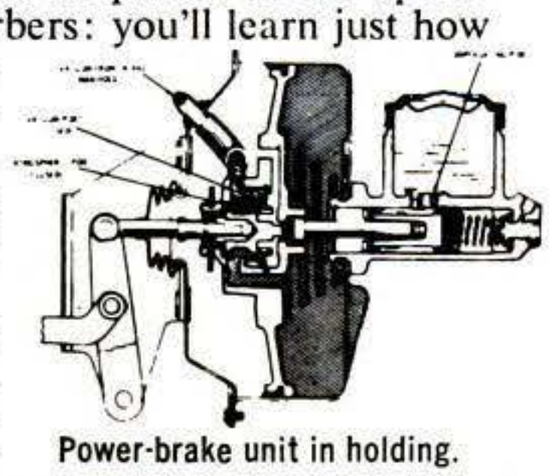

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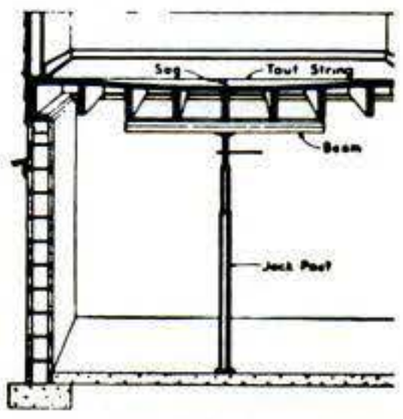

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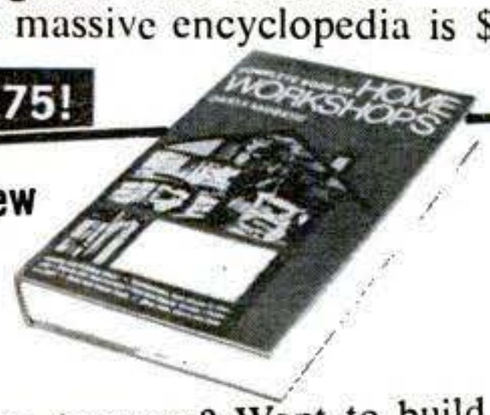

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by David X. Manners

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In all – nearly 500 pages, more than 550 photos, diagrams, plans, drawings, exploded views and cutaways and 12 valuable tables. All for your low PSBC price of just $4.75. (Regular price is $8.95.)

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Look at the New Binoculars

[Continued from page 61]

pupil, 7.1mm. 380′ field. Twilight factor, 18.7.

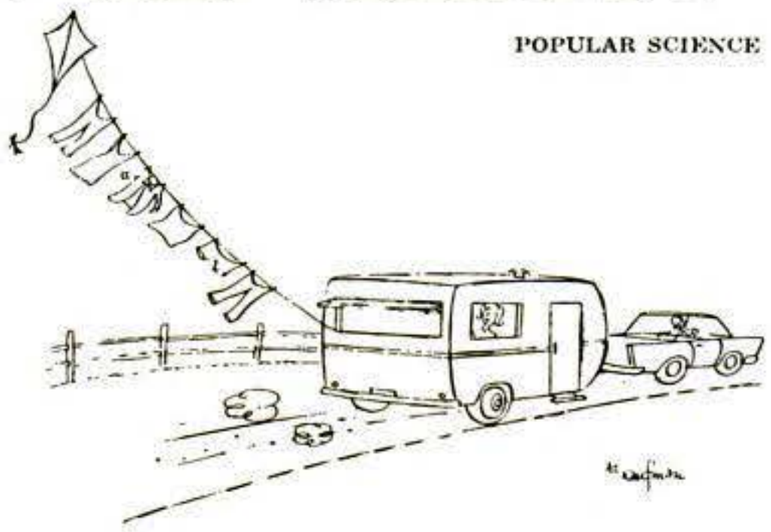
I wanted to try the fast-focus feature on a pair of big glasses, where I felt it most useful. These glasses (nearly three pounds) are very well balanced. The thumb-operated focus lever is faster and easier to use than most center-focus wheels and just as precise. I like the large exit pupil (they're considered "night glasses"). The rubber eyecups are great.

Jason/Empire #104 6x-12x30 electric power zoom. $119.95. 33 oz. Exit pupil, 5mm. 314′ field. Twilight factor, 13.4 (Specs are for 6x, zoom setting.)

These low-priced power-zoom glasses are fascinating, but heavy. Two little motors, gear train, penlight cells, and a bigger housing to hold it all are responsible for the weight. The zoom control button is placed just right and is easy to work. The motors are quiet and businesslike. Battery-test button and magnification indicator dial are well located. There is a concealed tripod socket—which you need for much 12-power viewing. The focus wheel is unhandy to reach. As the instruction booklet warned, refocusing is necessary when zooming stop to stop. Great fun at an auto race, viewing the pack at six-power, then capping in on an individual car.

Zeiss Mini-Binocular 8x20. $115. 4.75 oz. Exit pupil, 2.5mm 360′ field. Twilight factor, 12.6.

This one, at about one by two by three inches folded, has to be the tiniest of the compacts. In-line viewing prisms do the compressing. With eight power and the small exit pupil, you have to hold them pretty steady, but they're fine optically. Hunting, I carried the little things in a shirt pocket and forgot they were there. At first I disliked the lack of center focusing, but after they are focused for distance, they are ready to go for most viewing. They are well sealed, and so light I doubt if you'd hurt them at all by dropping them. But, of course, don't. PS



Aerobics for Sewage

[Continued from page 103]

dry wells or disposal beds will ru about the same as for conventiona systems.

Typical costs for the whole installa tion run in the $1,200 range. Other carry estimates slightly higher tha $2,000. Considering the importance c health and sanitation in our increas ingly crowded world, it is probably no too much for a family to spend a much on a lifetime treatment plant a it does for a car. The treatment plant properly maintained, will probabl function as long as you live. On manufacturer, Jet Aeration Co., actu ally offers a prorated 50-year war ranty to buyers.

Power costs for the electrical sys tem generally run less than $2 pe month—too little to fret about. Add t this the charges on a service contrac of $35 to $100 per year and you ar still operating in a very reasonabl bracket. Many septic-tank owners spend this much a year for pump ing.

How to go about it. If you find yourself with need for a new or re placement waste-water treatment system, it's best to make your peace with the local authorities early. If you're

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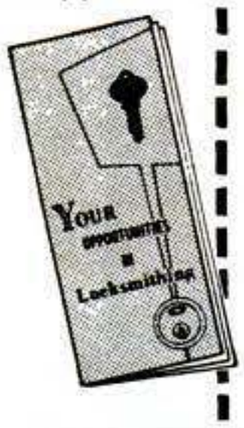

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contemplating the purchase of land for future building, it's doubly important. Before introducing yourself to the local inspector . . .

- Obtain a soil-absorption survey and valid drainage data on the site.
- Know your waste-water volume, number of users in the dwelling, and water-using equipment.
- Select a size and type of package unit that matches your family.
- Do not be vague about final disposal; know how you can handle it. If the effluent goes into a suitable absorption disposal point, as with a septic tank, authorities should have no real objections. But surface or stream disposal will be a sore point.
- Have valid performance data from a recognized testing agency on your chosen package plant.
- Have a workable plan for professional testing and service of the plant when installed. Check out maintenance contracts and inquire about on-call repairmen should a breakdown occur on a weekend or holiday.

With these facts you will be in a much better position to present your case and win approval. Even better, you will clarify for yourself exactly what to expect, and quite possibly, live happily rather than as a public nuisance for years to come. PS

You Need a Sander-Polisher

[Continued from page 81]

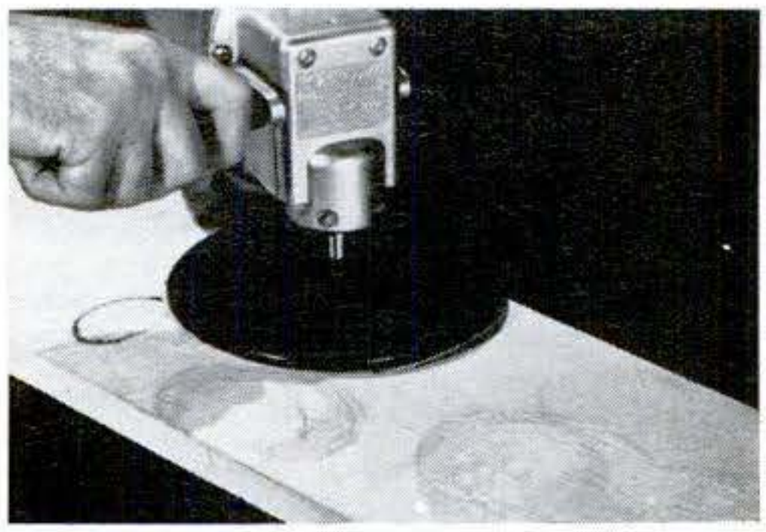
As a polisher, the sander-polisher's a husband-wife tool. With proper instruction and an accessory or two, the lady of the house will use it as often as you do. You'll both achieve glossy surfaces on your car, your furniture, and your floors that you couldn't get any other way.

Hints on handling. Never place the disk flat on the work when sanding. Tilt the machine a bit and apply just enough pressure to bend the rubber backup pad; usually the weight of the tool is enough. Too much tilt is as bad as none since only the edge of the disk is used, resulting in grooving the work. About 1/4 to 1/3 of the abrasive surface should be in contact.

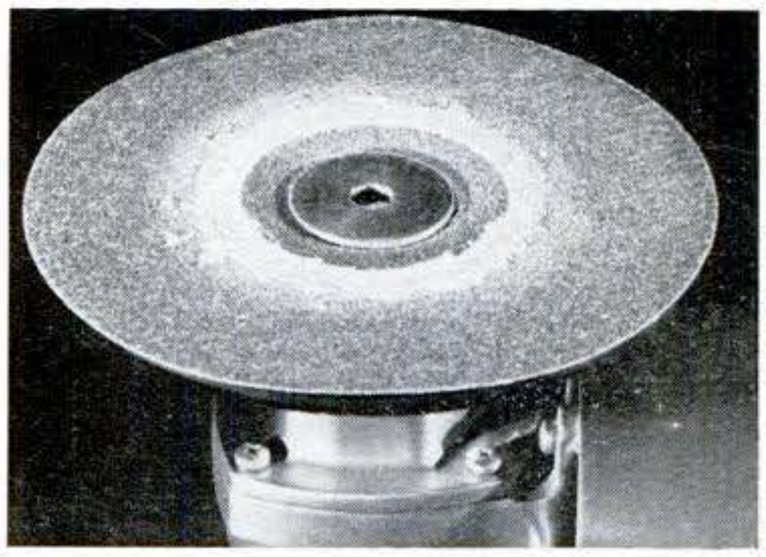
Start to spin the disk before you make contact and then use a sweeping straight-line feed with slightly overlapping strokes. Work with the grain for smoothest results.

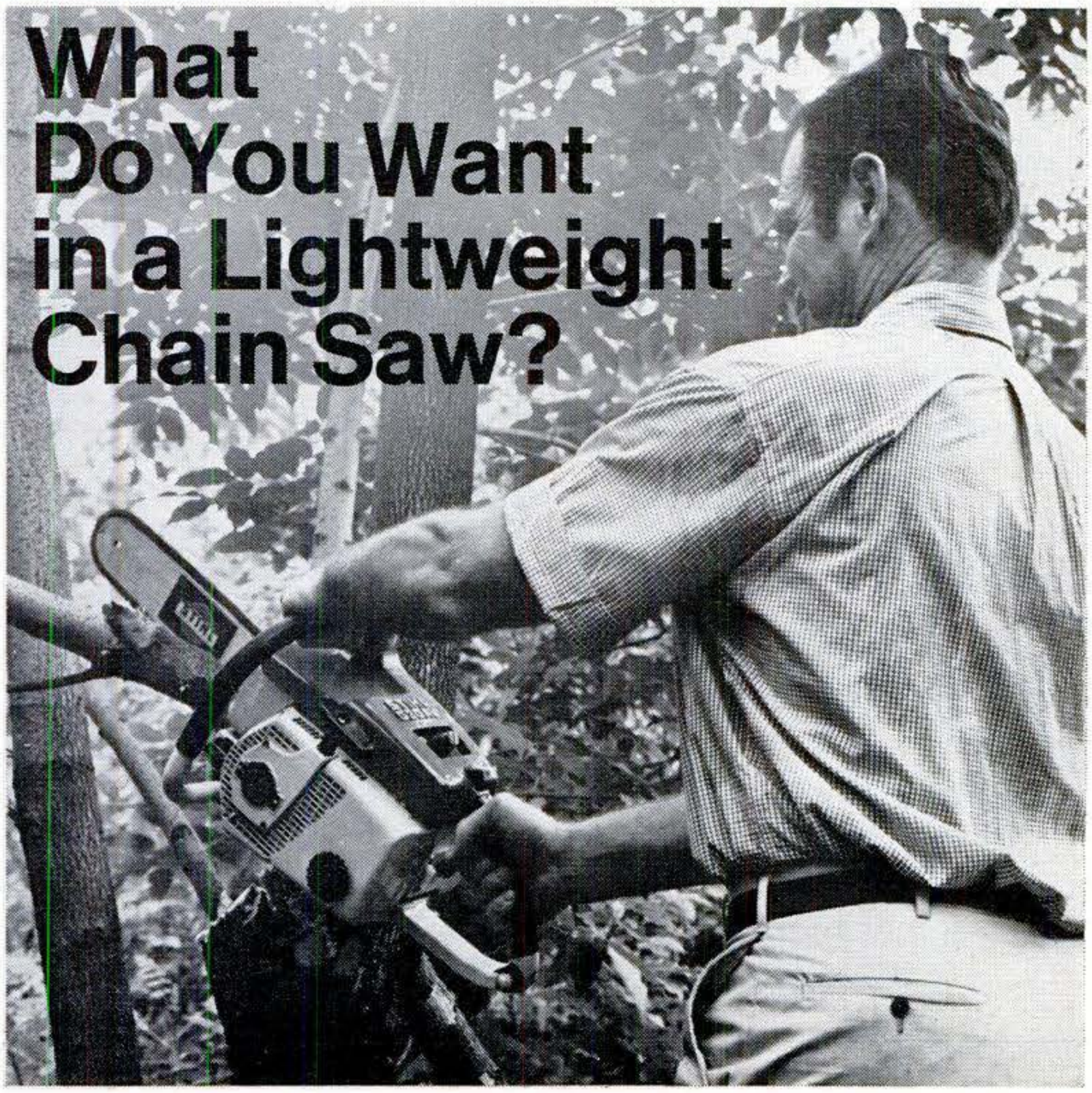
For most sanding, an open-coat paper is best; it's essential for paint removal. With a two-speed tool, if you find the high speed is causing paint to soften and glaze the disk, switch to low speed and faster feed.

And polishing? Handling is similar, but you can rest the bonnet squarely on the work surface at first, then finish up by using a segment of the bonnet in a sweeping motion. Keep the bonnet clean; when soiled, wash it in mild detergent, wring it out, mount it on the tool, and spin it. PS



Wrong way to sand is shown above. Holding disk flat on surface lets it cut circular grooves, makes tool hard to control. Center of disk will clog with waste, as below.





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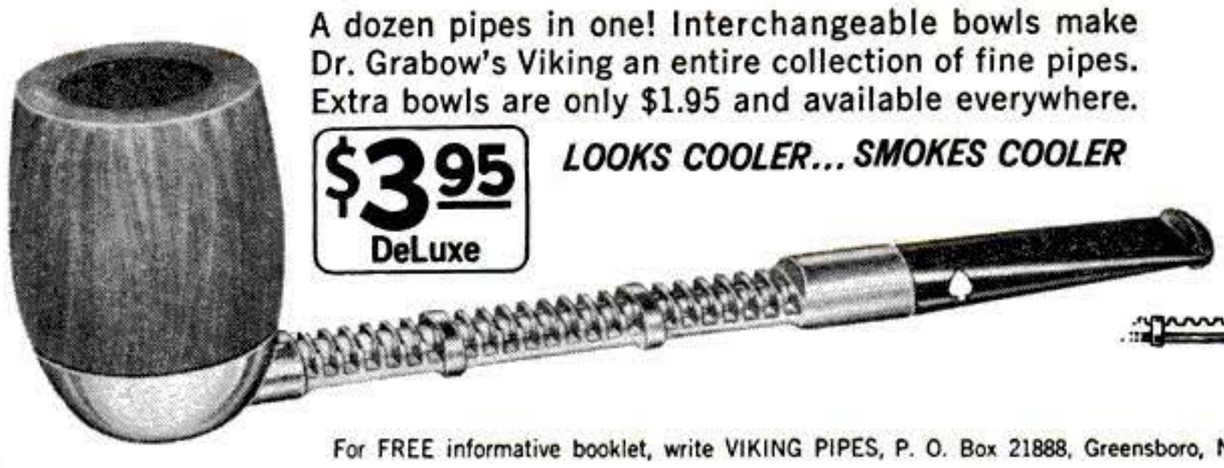

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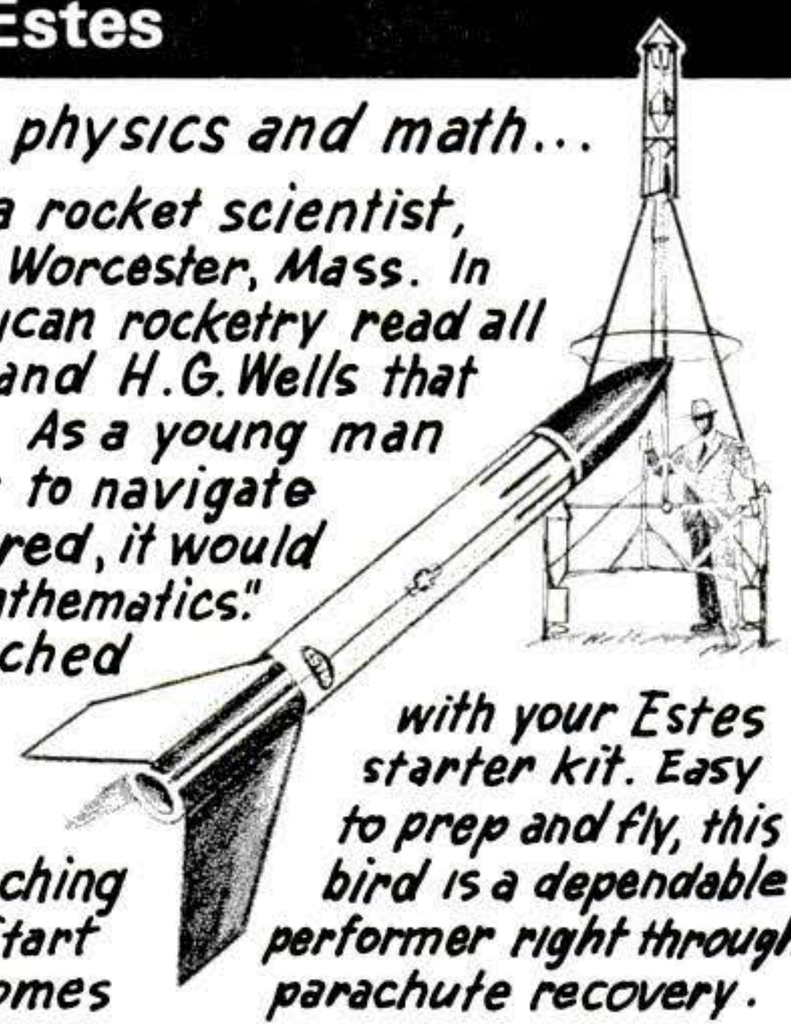

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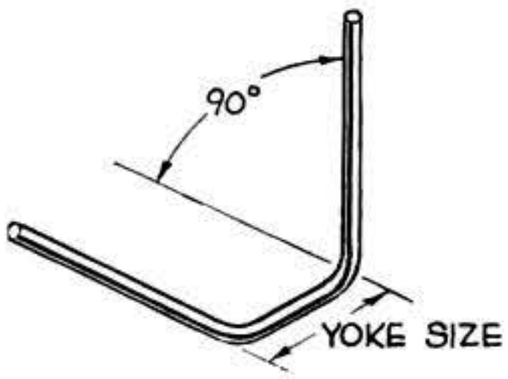

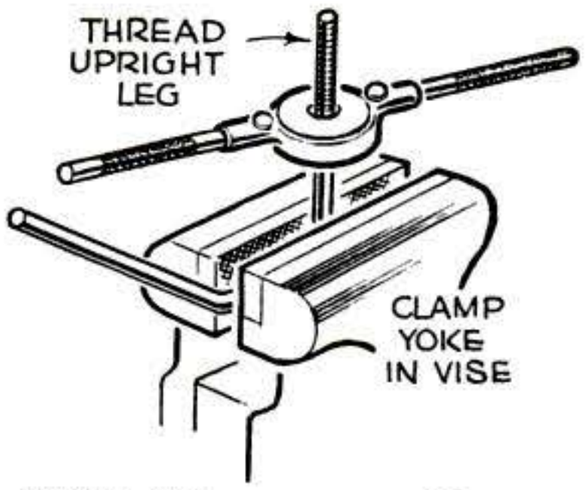

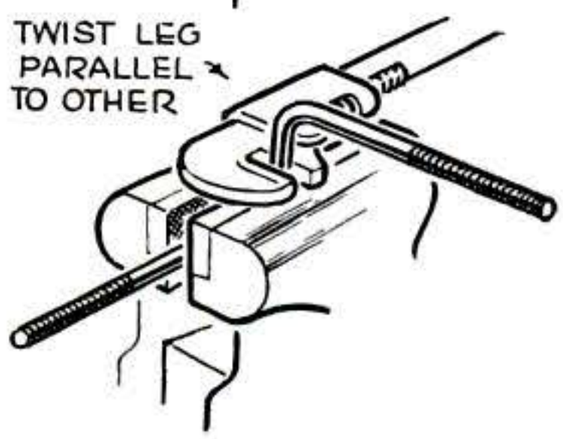

Easy way to thread U-bolt

If bent before threading, a U-bolt leaves no clearance for swinging a die stock. If the rod is threaded and then bent, the threads are likely to be damaged in the process.

This method makes the job almost foolproof: Bend the two large legs on a piece of unthreaded rod, making the bends the desired diameter apart but at 90 degrees to each other, as shown. Clamp the piece in a vise by the center section, with one leg vertical, and thread that. Then reclamp it with the other leg vertical and thread that. Finally, grip the unthreaded part of one leg in the vise and bend the other leg parallel to it, using an adjustable wrench.

JOHN KANE, Whittier, Calif.

Pipe-laying trick

PVC pipe allows no second chance once you've joined fittings and applied cement. The joints set immediately. To avoid errors when installing waste lines in a bathroom, I used this trick: After cutting the pipe, I assembled it with fittings in place under the floor. I then marked pipe and fittings at each joint with a permanent-ink felt-tip marker. Removing the system to the floor, I cemented it into subsystems, using the ink marks to align each joint. Finally, I placed the subsystems under the floor and assembled them, using the ink marks again as a guide.

GEORGE MEANS JR., Warren, Pa.

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Folding Table for Baby's Bath

When it came time for our newborn son's first bath, my wife found there was no place in the cramped bathroom to put the baby's plastic bathtub.

My solution is a fold-down washing table that hinges to the wall in the unused space over the toilet. The table takes about 15 seconds to set up or swing away. It provides a place to set the tub, as well as extra space to set the baby down when towelling him dry. The tub is easy to fill from the adjacent hand shower, and easy to empty into the large tub when the bath is over.

I made the table from 3/8" plywood —exterior grade to hold up after repeated soakings—and covered the exposed edges with half-round molding. The molding gives the table a finished look, and helps reduce the danger of splinters.

Three coats of non-toxic (lead free) enamel give the table a smooth finish for an easy afterbath cleanup.—*Robert M. Glazer, M.D.*

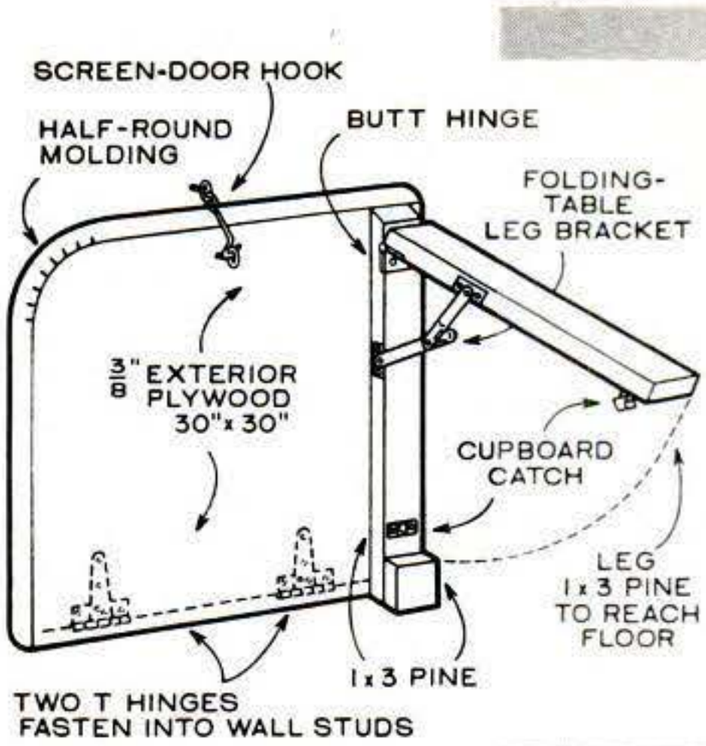

Table swings down for baby's bath, swings back out of the way when the washing's done. T-hinges, bolted to the thin plywood table, are screwed to the wall studs. A leg made of 1"-by-3" pine is fastened to the table with a folding leg bracket. It provides support when the table's in use, locks out of the way with a cupboard latch during storage. A screen door hook and eye holds the table against the wall between baths.

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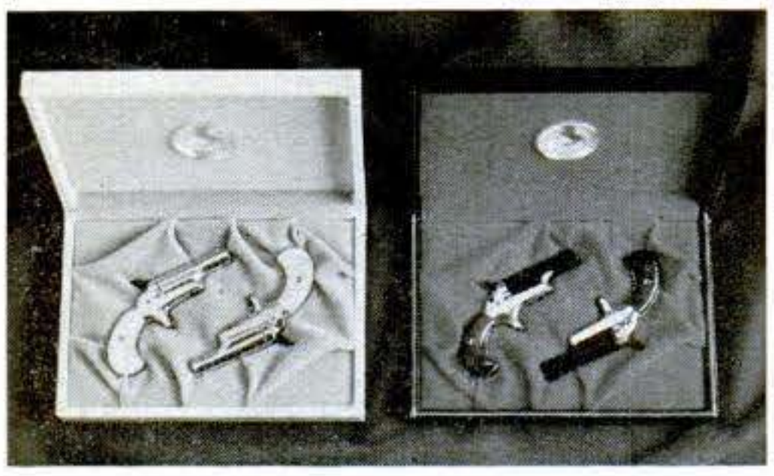

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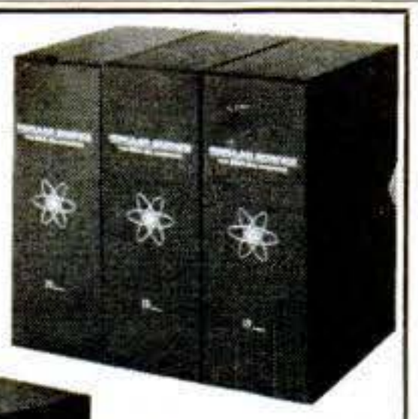

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Come Dive With Me to Tektite II

[Continued from page 55]

bell 5½ feet in diameter, which serves as an elevator. At each ascent, it is joined to a decompression chamber on the barge's deck for transfer of its occupants, until the whole crew is in the chamber. Then the pressure in the chamber is gradually lowered to atmospheric, over a period of at least 19 hours.

This extended post-mission decompression period is a small price to pay for the advantage of "saturation diving," in which operations are conducted from a pressurized undersea base. From their habitat open to the sea, Tektite II aquanauts go and come as they choose—making excursions hours long and returning, without need of decompression between successive sorties. They range the ocean bottom with almost the same freedom as the fish.

Besides its main habitat, Tektite II has a 100-foot-deep outpost—a smaller two-compartment "Minitat" sited 1,600 yards southwest of Beehive Cove, and supported from a surface vessel instead of from ashore. After a two-week mission, this midget habitat is raised to the surface and its crew of two undergoes about 36 hours of decompression.

The first women aquanauts. Arriving between missions did not deny me a view of mission activities. As it happened, the next crew to occupy the main habitat would be the team of women aquanauts. In dives from shore they were already practicing the operations they would perform later from the habitat.

Their professional skill impressed me, and so did their self-reliance. With no male help wanted, they toted their own tanks and other heavy gear. Repeatedly I had the pleasure of swimming out with them and seeing what amounted to dress rehearsals of their mission.

I watched Dr. Sylvia Earle Mead, who headed the Scripps team, and Dr. Renate True lay out a 1,000-foot line on the sea floor that would form an integral part of an experiment in marine ecology. For their first time, but like veterans, they were using a hand-held pinger receiver (sonar homing device) to swim a course.

On a swim the day before, I saw the team prepare equipment for another ecology study by Ann Hartline and Alina Szmant. Peggy Lucas, the team's engineer, went along on another occasion, when all five girls were in the water at once.

That was a rare and somewhat eerie sight. Five girls clad in bright-orange wetsuits, with stark white backpacks, working on their projects in brilliant blue-green water, m a splash of color that I'll remem An unusual part of the spectacle the absence of bubbles.

The team was building up ex rience with closed-circuit, mixed- scuba—an innovation that their T tite II mission would be the firs put to use. Instead of exhaustin diver's exhaled breath to the sea an open-circuit scuba does, it absc carbon dioxide and recovers unu oxygen, to supplement the mixt entering the inhalation bag from tanks ["New Underwater Breath Systems," PS, Nov. '69]. The gi closed-circuit gear, designed by G eral Electric, is one of three curr versions.

Major advance in scuba. T closed-circuit type of gear will pr to be the most significant adva since man began self-contain breathing under water. A new dep ture—in saturation diving especia —it has such greatly extended durance at depth that it keynotes future of all underwater work.

Because it is silent it has spec value to a diver-scientist. A hissi regulator and bubbles escaping fr open-circuit scuba must sound li explosions to the creatures that li in the sea. To be able to approa them without shattering the silen of their world is to be able to obser true behavior.

Development of this gear has n reached a stage that permits its c erational use. This has awaited oxygen partial-pressure sensor that reliable through a large range total pressures. Such a sensor, t heart of the device, is now provid in triplicate. If any one of the thr sensors gives an out-of-limits indic tion, the diver is warned visually aurally in time to return safely the habitat.

What Tektite II demonstrates to visitor, above all, is the rapid dev opment of the technique of saturati diving. It means that man is longer restricted to short visits the sea floor. He can live there long as he pleases.

Warm-up for photo trays

While working in a cold darkroon you can keep developer and othe solutions warm by laying a strip o electrical heating tape under th trays. By plugging and unpluggin the tape from time to time, you ca hold the temperature of the solution just where you want it.

ROBERT GUGETT, Hamilton, Ohio

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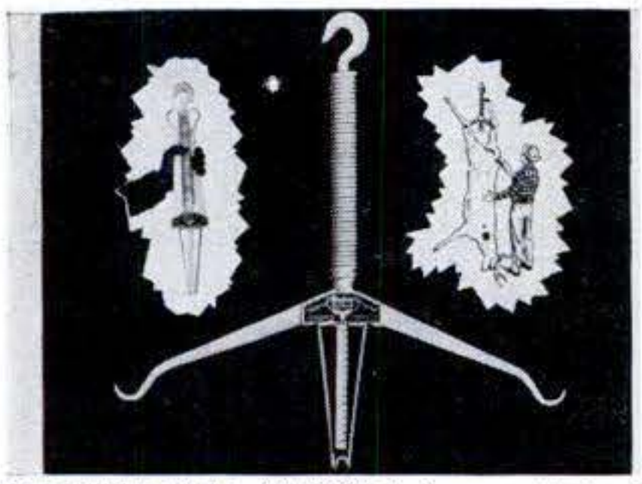
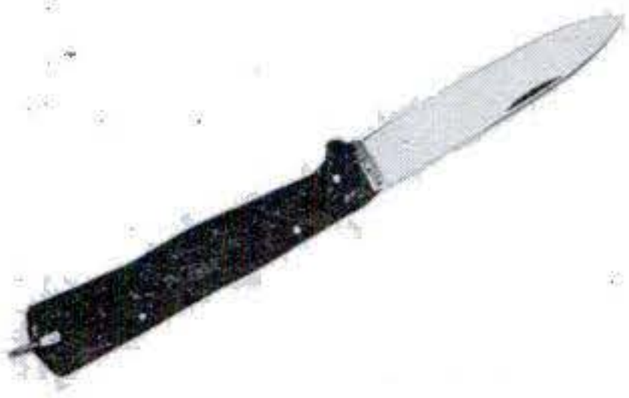
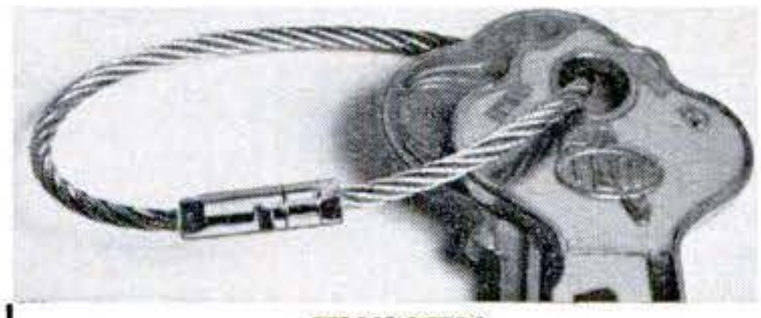
Shoppers'



GET THE FULL WEIGHT of your game before it dries out, shrinks or is trimmed with this new weighing Grambrel, guaranteed 100% accurate. Scale locks rigid for skinning. Weigh fish, elk or beef quarters, pack boxes, etc. The Gambrel folds for convenient handling. Made to last a lifetime. $17.95 ppd. Benbow Products Co., Dept. PS-10, 325 Industrial Park Dr., Carson City, Nev. 89701.



IF YOU'VE BEEN Looking for a compact, lightweight, rugged pocket knife, here's one that fills the bill. All metal construction with a locking finely tempered blade that measures 4" long. High quality excellent German craftsmanship, this knife will serve you well for years. Only $2.00 + 25¢ postage. Barclay, Dept. 58, 170-30 Jamaica Avenue, Jamaica, N.Y. 11432.



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How to get rich

How can you get rich some day? Make a hit record . . . a killing on the stock market . . . or invent a gadget like the hula hoop?

For most of us, these are just dreams. But have you ever stopped to think that there *is* a way to get rich—possibly only one sure way? Most fortunes, as you know, are made by people who own their own business.

Perhaps you've thought of starting a small business of your own . . . a franchised drive-in, or maybe a service business. Trouble is, you need $10,000 to $15,000 to get started and even then it's a gamble—with slim chance of ever making really big money.

But there is *one* business which could make you rich—almost overnight. And the beauty of it is, you can start on a shoestring during your spare time, even while holding your regular job.

Cash by Mail

The business is Mail Order—and it's fabulous! Come up with a 'hot' new item . . . and WHAM!

It strikes like a bolt of lightning!

Suddenly, you are deluged with cash orders from all over the country . . . MORE MONEY than you could ever make in a lifetime!

Like the Vermont dealer who ran one ad in Sports Afield Magazine. His ad pulled 22,000 orders—over A HALF MILLION DOLLARS IN CASH!

There is no other business where you can make a fortune so quickly!

• A beginner from Newark, N.J. ran his first small ad in House Beautiful—offering an auto clothes rack. Business Week reported that his ad brought in $5,000 in orders. By the end of his first year in Mail Order, he had grossed over $100,000!

• Another beginner—a lawyer from the midwest, sold an idea by mail to fishermen. Specialty Salesman Magazine reveals, "he made $70,000 the first three months!"

Proof

It's a fascinating business! Running ads in newspapers and magazines . . . mailing gift catalogs . . . getting cash orders in your daily mail—steady as clockwork.

There is no other business where you can start on a shoestring and pyramid your profits—*without investing in merchandise!* One husband and wife mail order team took in $40,000 selling one item. They obtained FREE ads in national magazines . . . didn't invest a cent in merchandise, and even got the supplier to ship all orders for them!

These exceptional cases are absolute proof that *you can get rich* in your own Mail Order business. Very rich. Even a U.S. Gov. Report stated: "A number of one-man Mail Order enterprises make up to $50,000!"

Pick up any magazine. Notice how the same mail order ads are repeated . . . month after month? That's concrete proof! You know those ads wouldn't be repeated over and over again—*unless* they were bringing in big cash profits to their owners.

The Secret

The secret of getting rich in Mail Order lies in *financial leverage*. It's a little-known, almost secret method—using other people's capital to make money for you!

You can get thousands of dollars worth of advertising in big national magazines—without investing your own money! And you don't have to write a single ad. Tested and proven ads are prepared for you by experts. Reinvest the profits from your first successful ad—to get more, larger ads, and the profits begin to snowball! It's like building a chain of stores . . . each new store puts more money in *your* pocket.

You mail out beautiful catalogs which offer hundreds of dollars worth of fine, quality gifts—yet you don't invest one cent of *your* own money

The thrill of receiving money in your mail is one you'll never tire of!

in merchandise! Your catalogs are printed with your name and address, so all orders come to you. Everything is "drop-shipped" for you, and there's up to *100% mark-up!* You pocket the cash profits immediately—even before the orders are shipped to your customers!

Repeat orders alone, just from mailing catalogs, could bring you a steady income for the rest of your life!

Yes, Mail Order is the fastest-growing, most profitable business in America! And now, with more people moving to the suburbs . . . the population explosion . . . and the expanding teenage market . . . we are on the verge of the BIGGEST BOOM in Mail Order history!

Now, with the help and backing of Mail Order Associates, Inc., of Montvale, N.J., you can follow the same proven steps to Mail Order success—using the 'secret' of financial leverage!

Start Now

We supply you with beautiful gift catalogs throughout the year. All products are drop-shipped for you, with up to 100% mark-up! You get free samples of top-selling mail order items, plus monthly trade reports on 'hot' new products . . . tested, successful ads are sent to you monthly. You get advertising directories, postal laws, complete courses, expert guidance—EVERYTHING you need to practically guarantee YOUR SUCCESS. Why? Because *our* business depends upon *your* success. It's mutually profitable!

A recent feature article in Income Opportunities Magazine stated, "Mail Order Associates Inc., offers the most comprehensive Mail Order program ever offered to beginners." They go on to say, "This could be the opportunity you've been looking for. A chance to get in on the ground floor in a little known business which we believe is on the verge of a new boom."

Free

We are now accepting a limited number of charter members in our new Mail Order Program. No previous experience is required but you must be over 21.

If you are sincerely interested in starting a profitable business on your own . . . if you can see the tremendous advantages which Mail Order offers . . . then ACT NOW!

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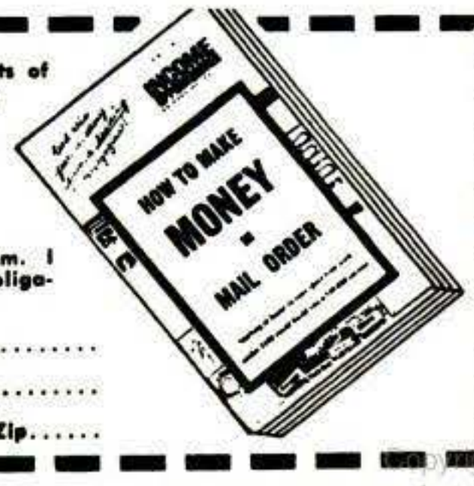

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Montvale, New Jersey 07645

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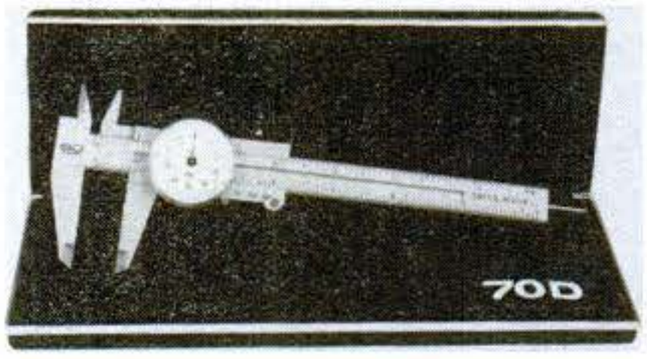

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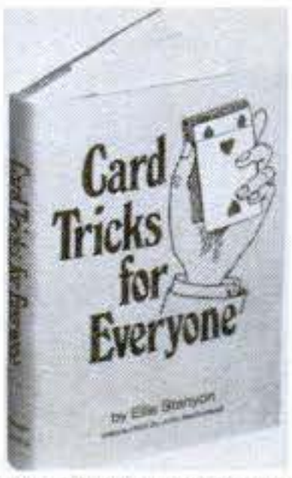

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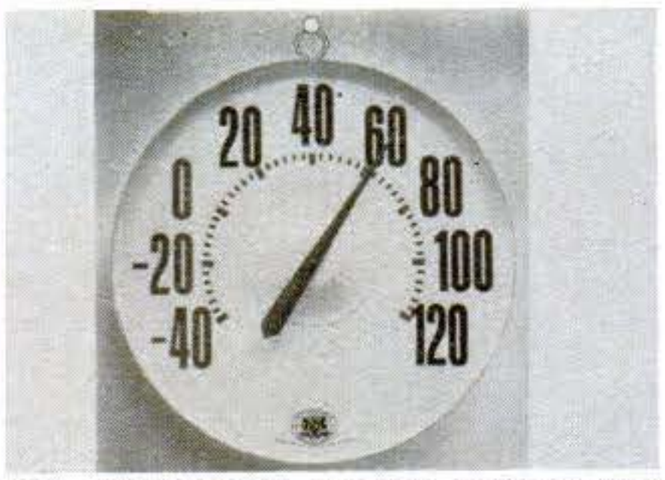

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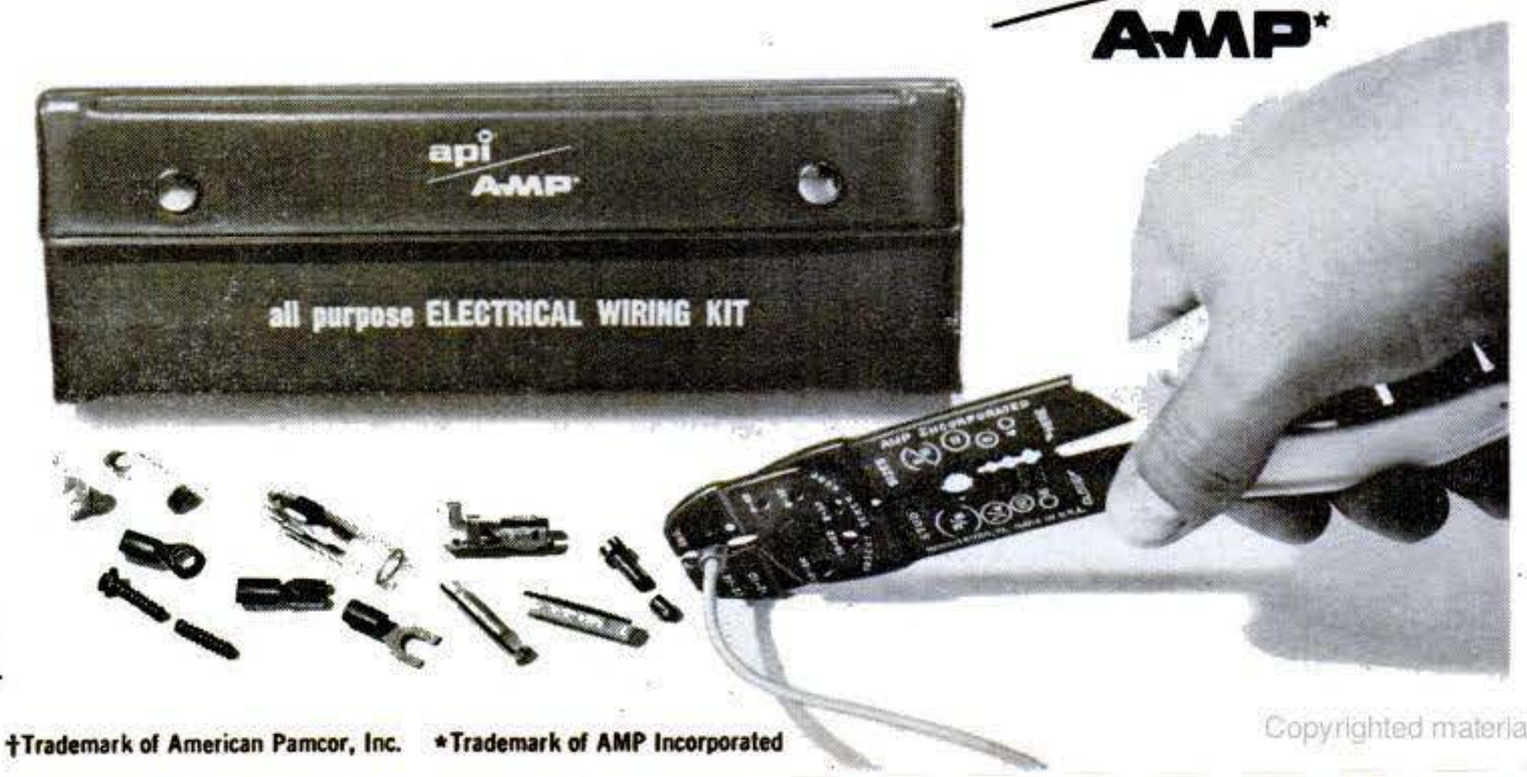

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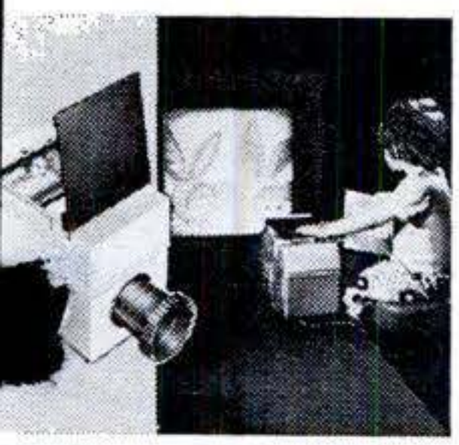

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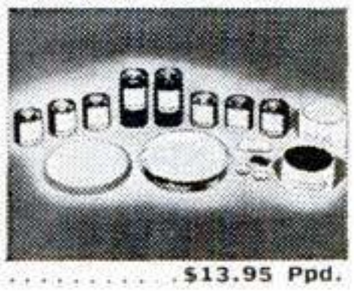

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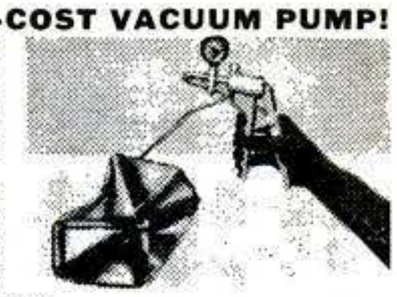

Nothing like it! Top-quality hand-held pump produces & maintains 25" of vacuum. Has instant release tab. 1⅝" diam. stainless gauge (0-30"). 100's of uses—siphon noxious fluids, evacuate bell jars and castings, clean, retrieve, lift sterile objects, demonstrate Magdeburg hemispheres, bleed fuel lines, check leaks, etc. Lifts 40 lbs. with included "T" Lifter (2½" diam. cup)—much more w/ larger cup.

Stock No. 71,301N ..... **$12.00 Ppd.**
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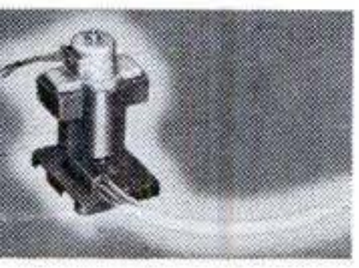
MINIATURE WATER PUMP



Wonderful for experiments, miniature waterfalls, fountains, etc. Tiny (2⅝" x 1¾") electric motor and pump ideal for hobbyists, labs, schools. Pumps continuous flow of water at rate of one pint per minute at a 12" head. With two "D" batteries in series, will pump up to 24" high. Runs 48 hours on battery. Works in 2 directions. Self-priming.

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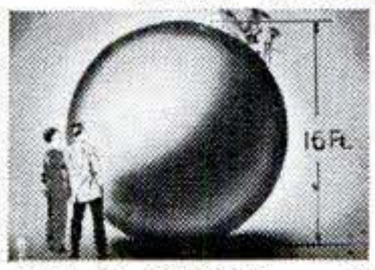

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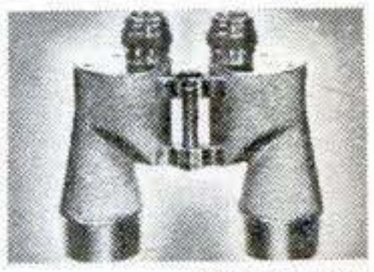

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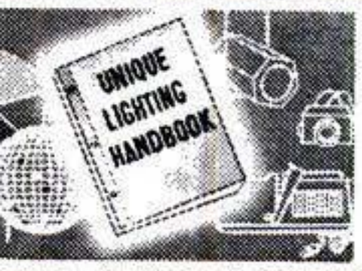

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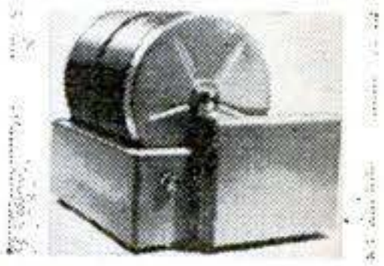

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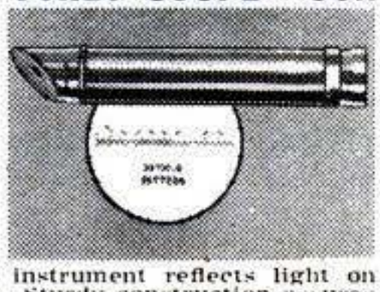

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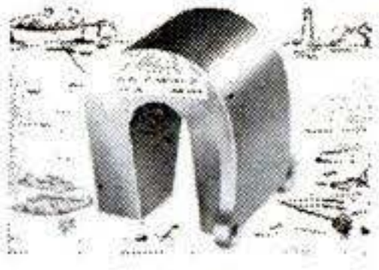

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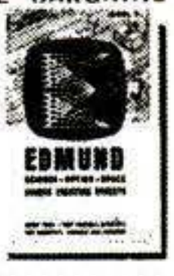

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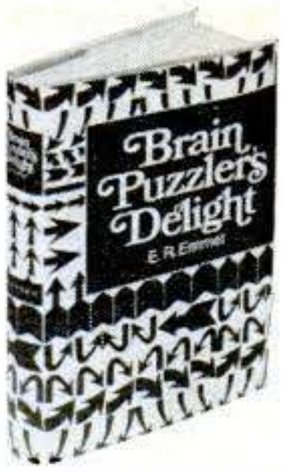

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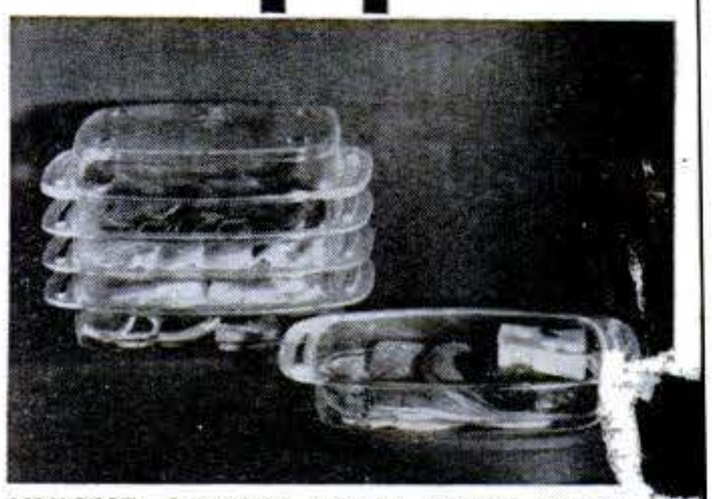

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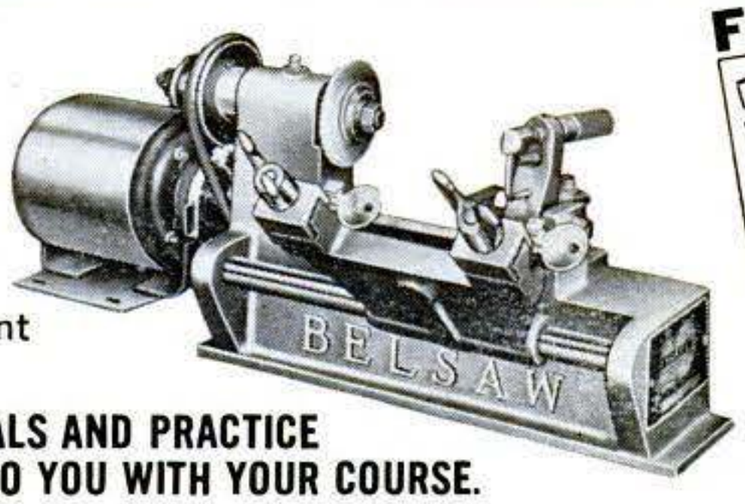

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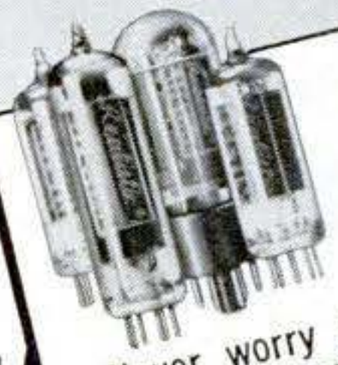

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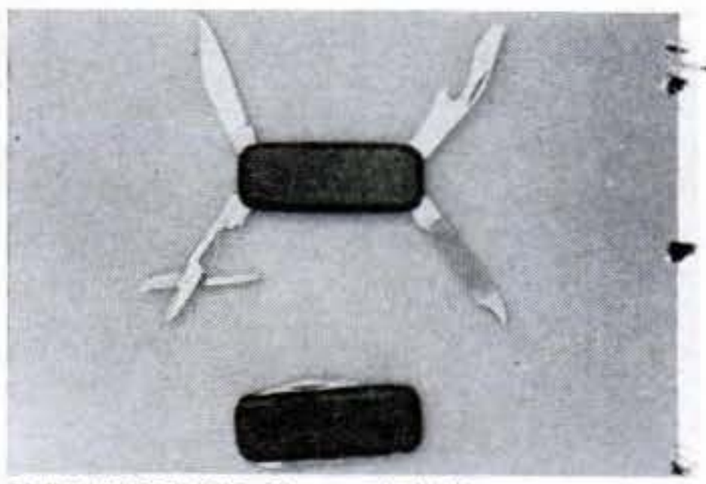

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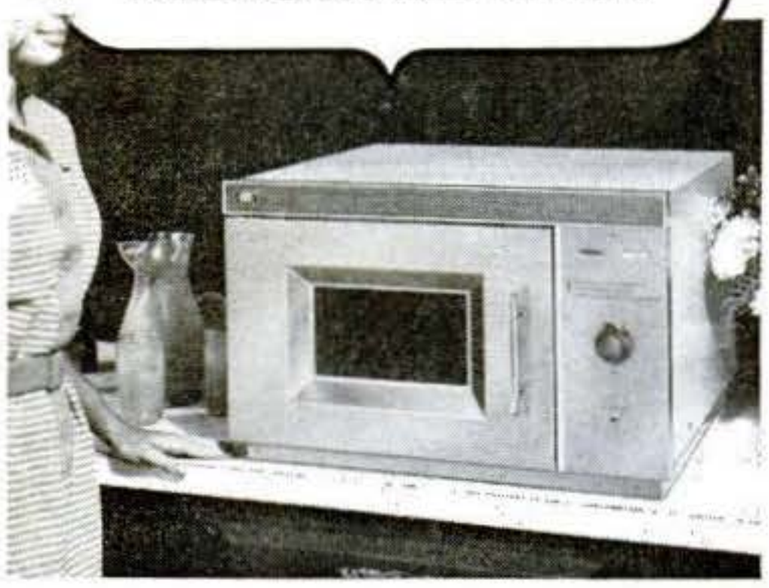

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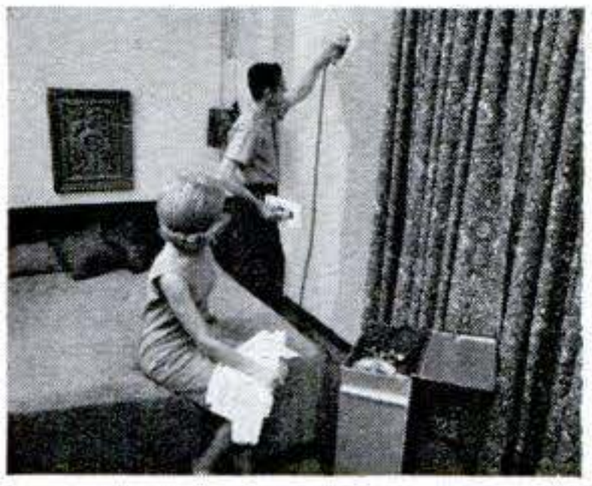

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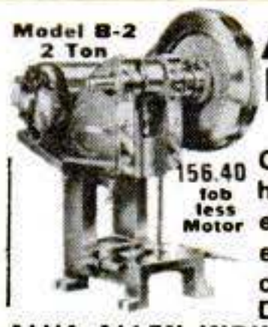

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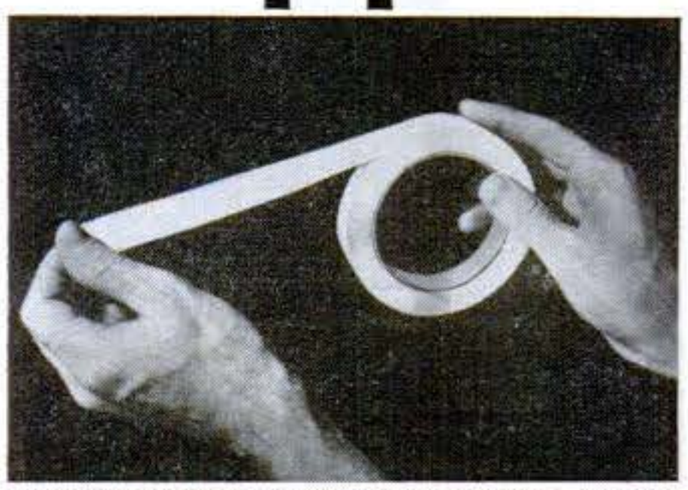

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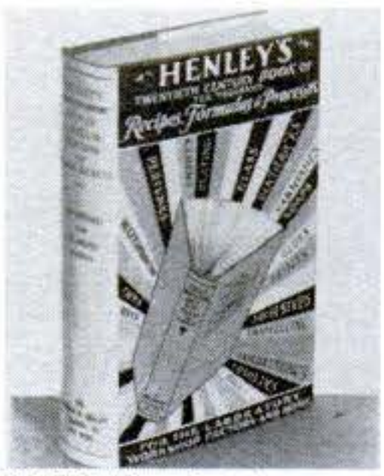

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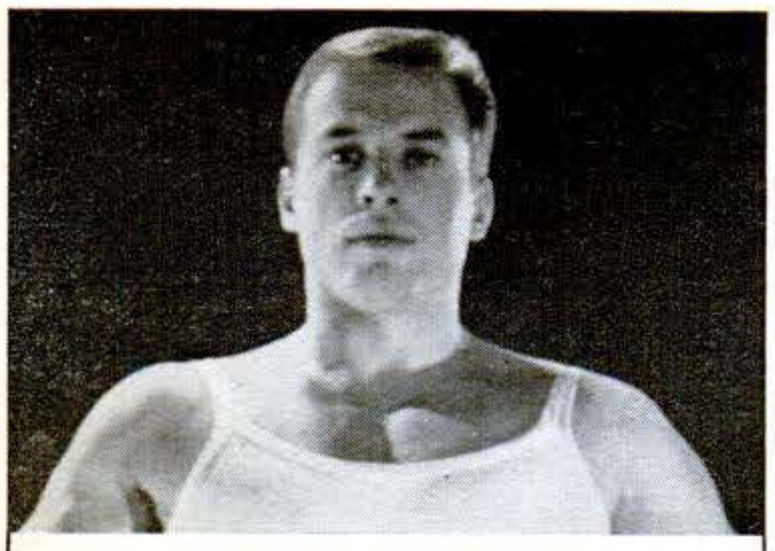

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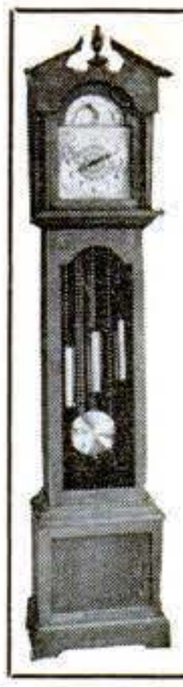

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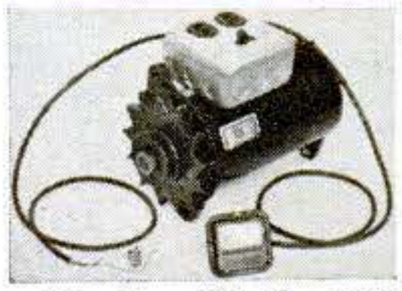

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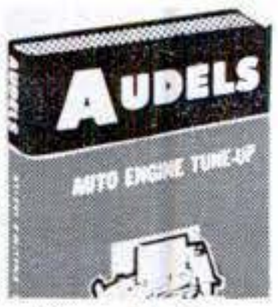

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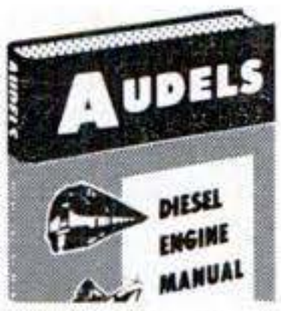

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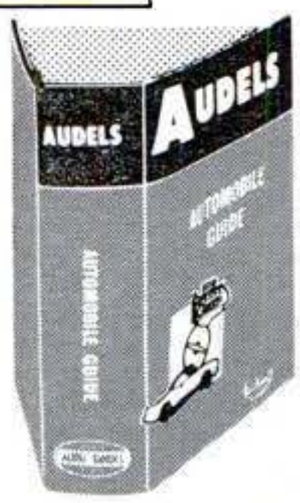

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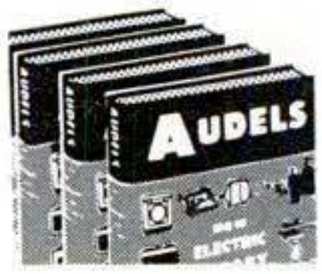

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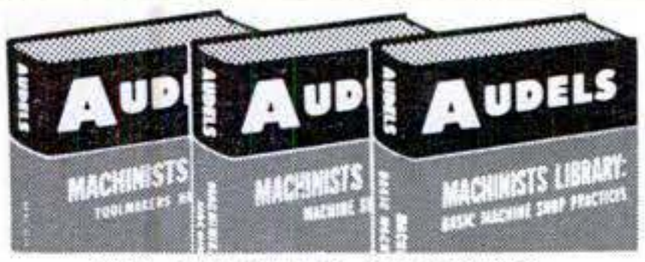

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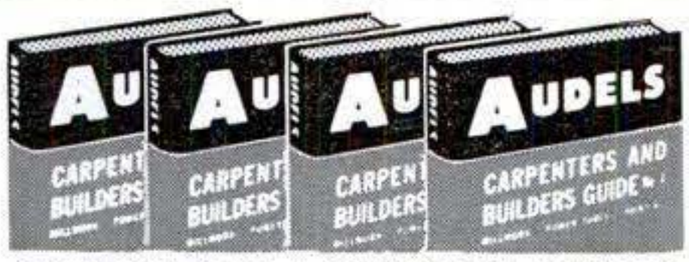

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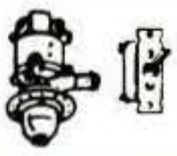

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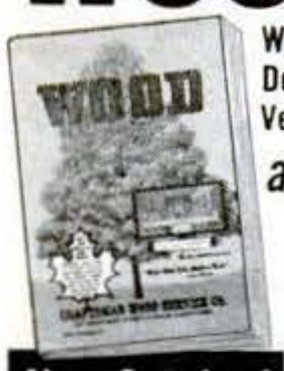

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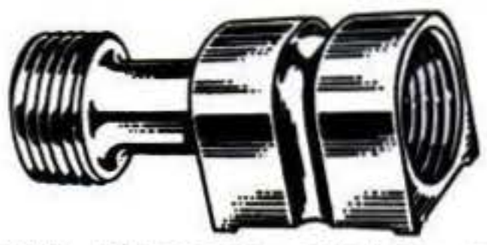

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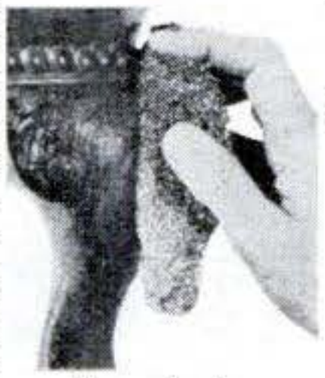

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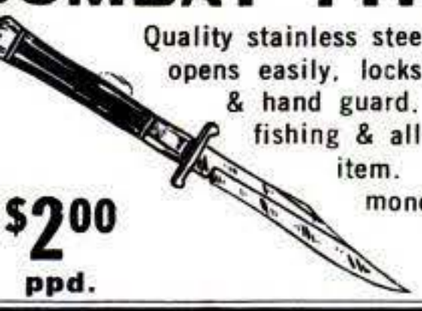

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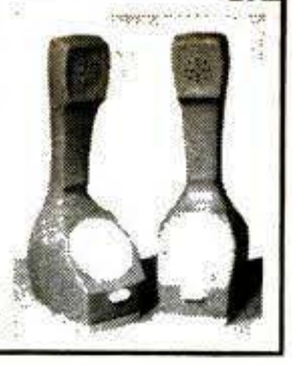

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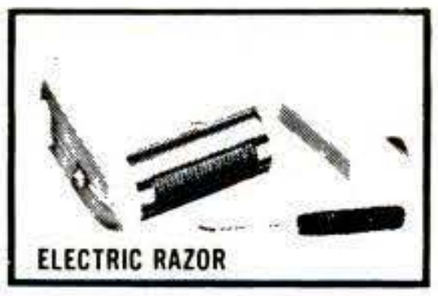

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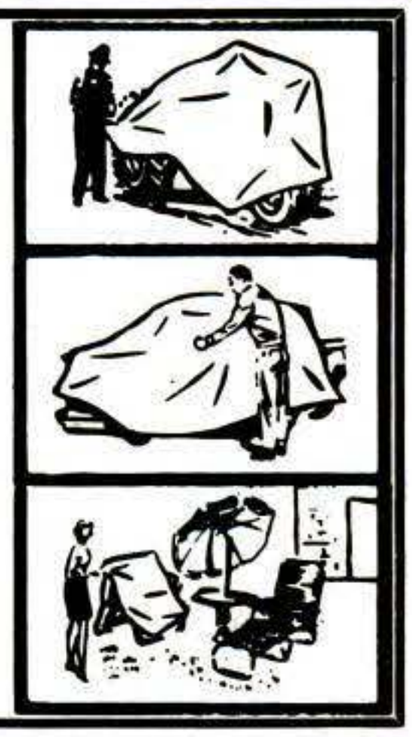

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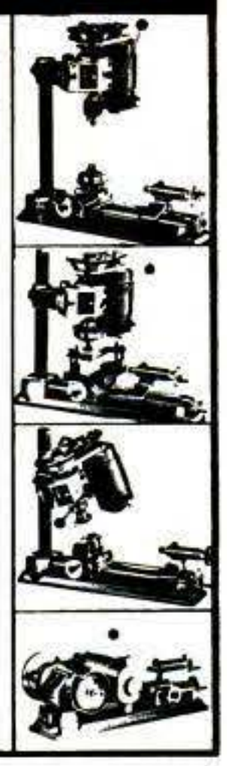

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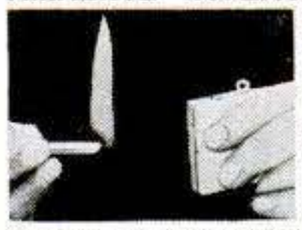

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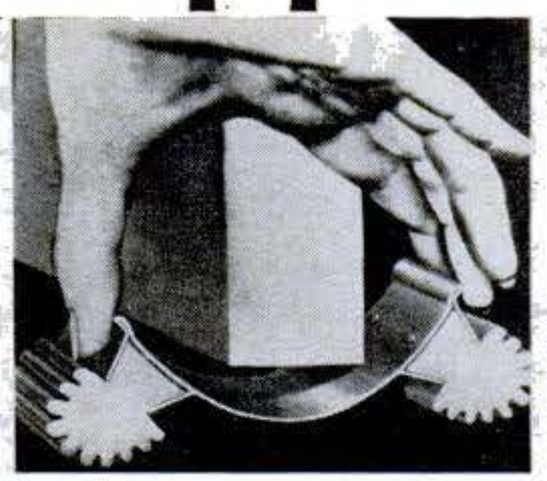

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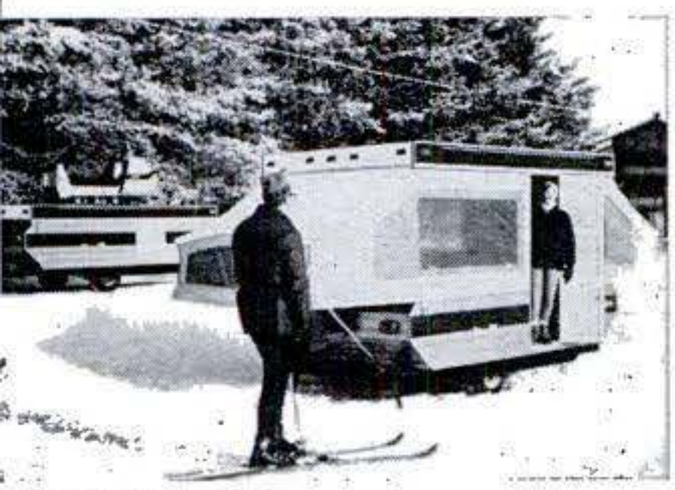

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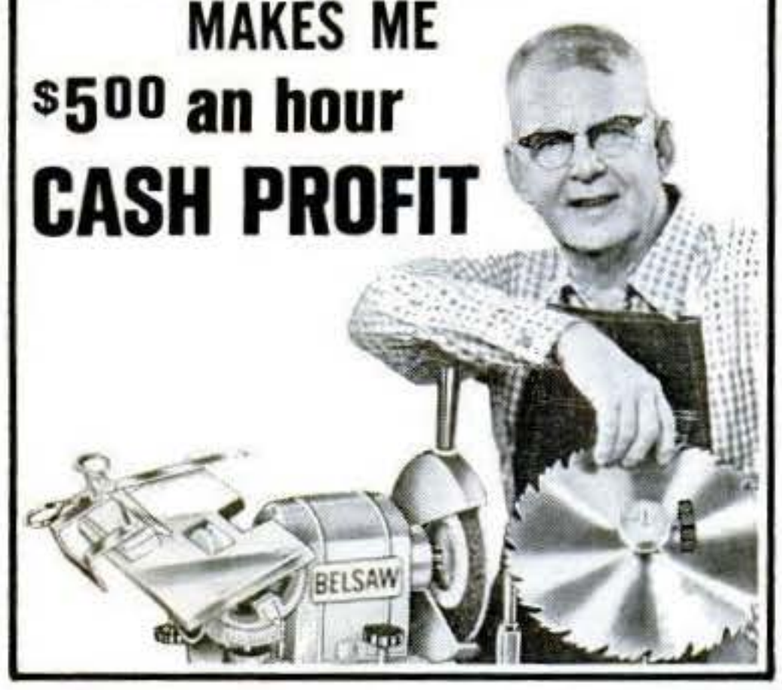

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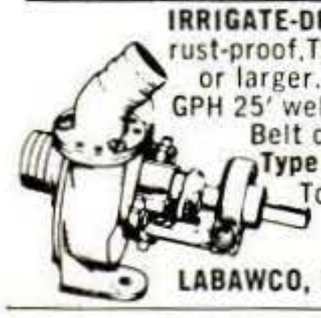

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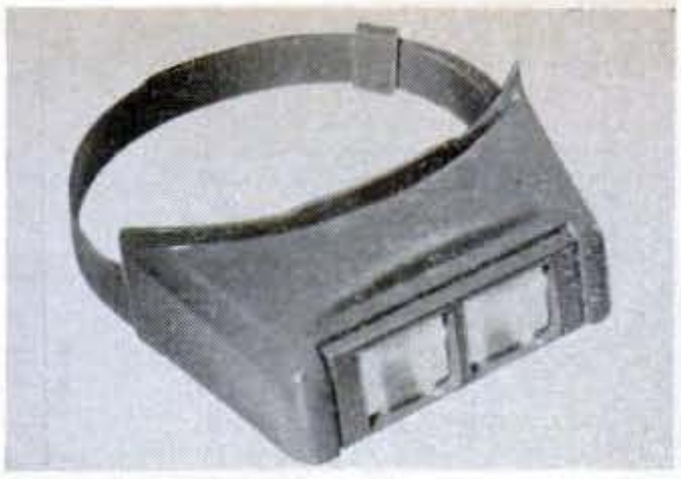

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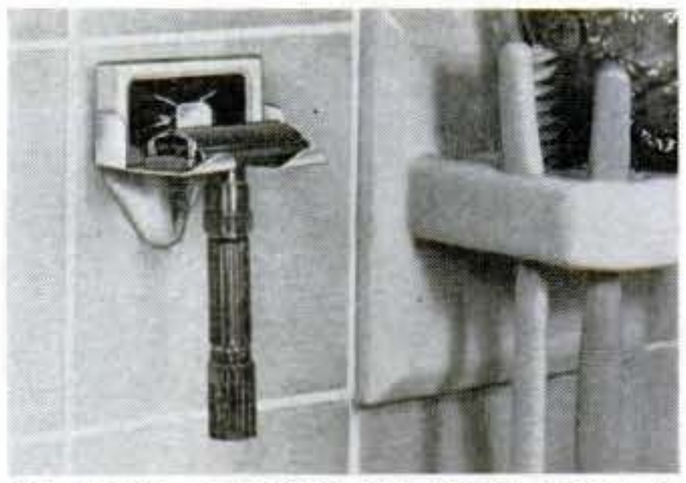

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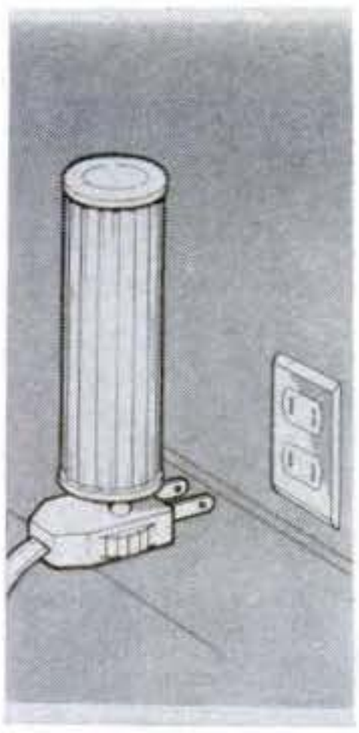

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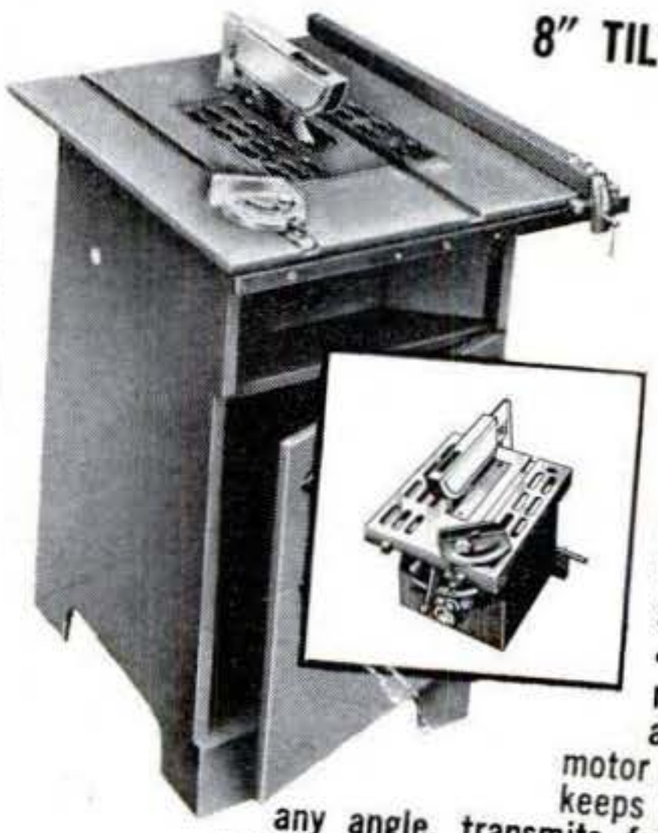

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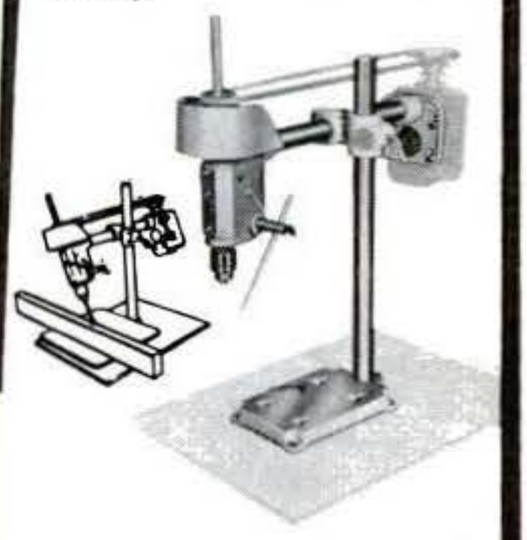

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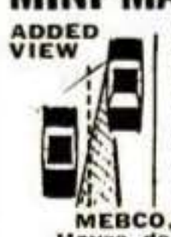

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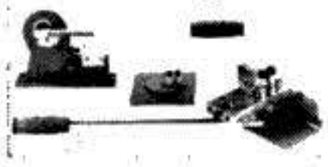

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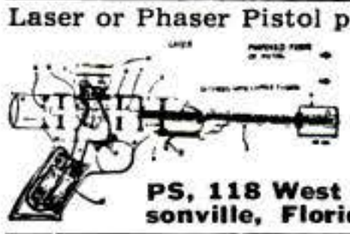

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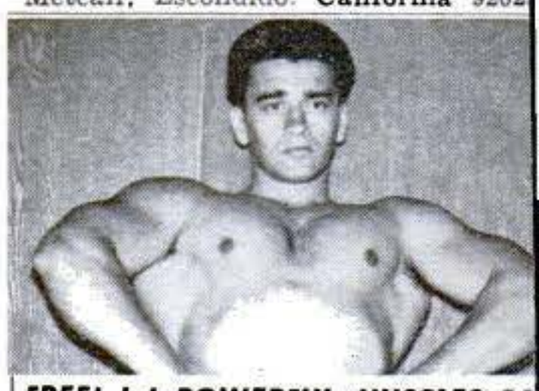
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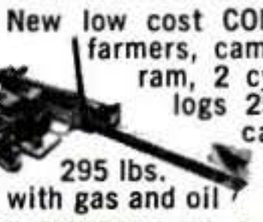

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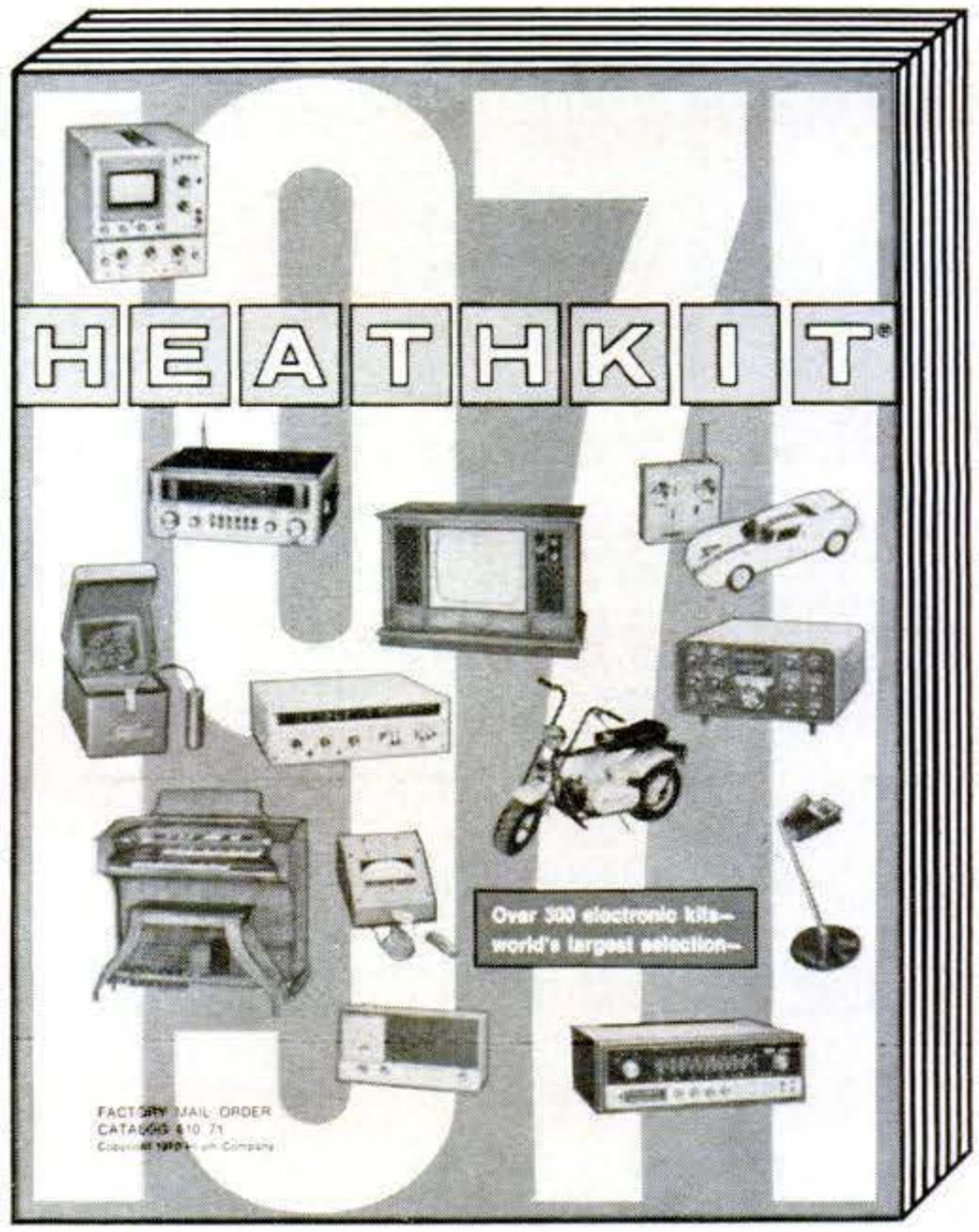

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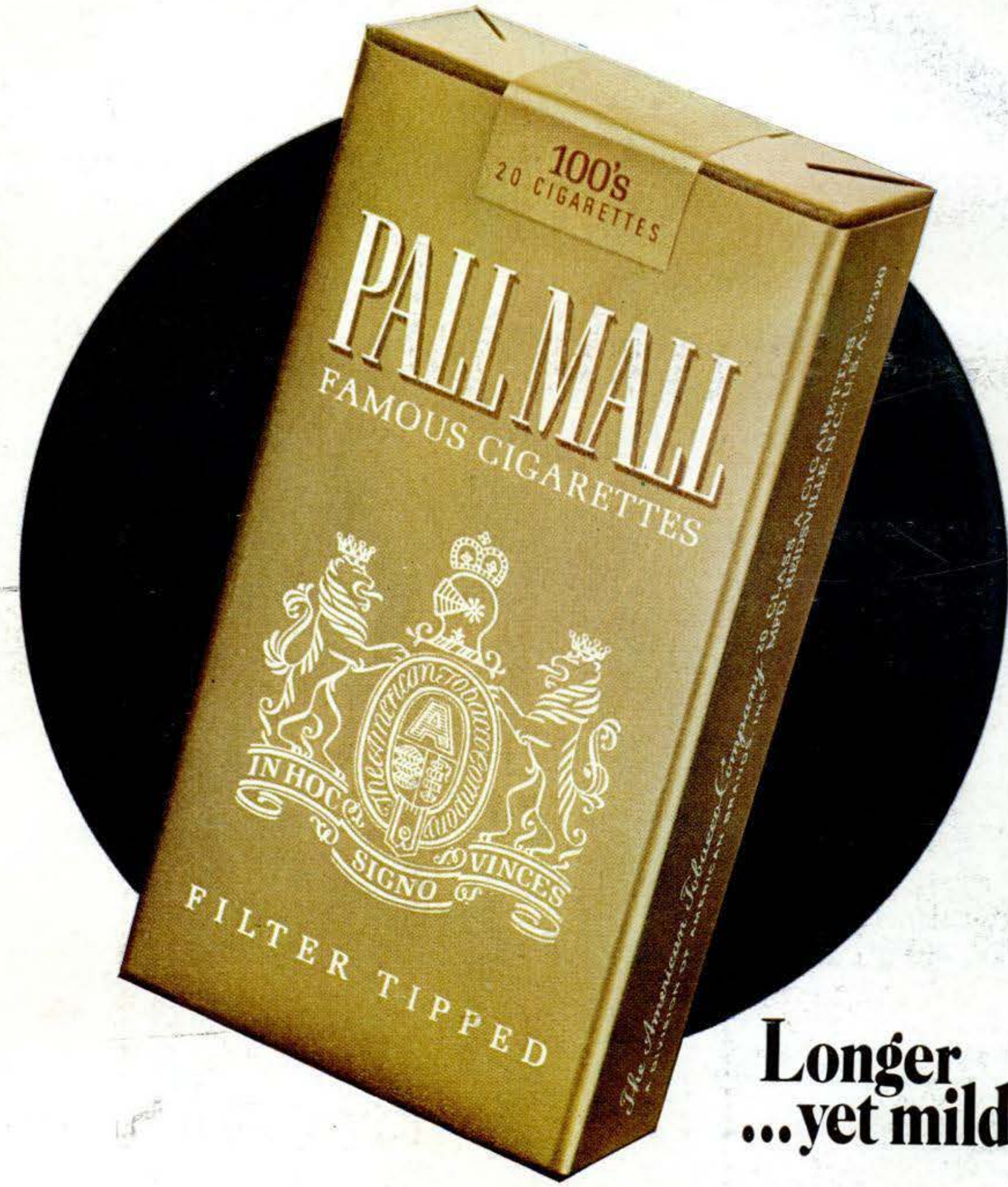

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